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ON THE EPIBIOTIC AND PELAGIC CHLOROPHYCEAE, PHAEOPHYCEAE, AND RHODOPHYCEAE OF THE WESTERN SARGASSO SEA

WILLIAM J. WOELKERLING

This paper provides a taxonomic account of the epibiotic and pelagic Chlorophyceae, Phaeophyceae, and Rhodophyceae collected during six cruises to the Western Sargasso Sea and follows two previous studies by the author (Woelkerling, 1972; 1973) of non-planktonic algae from this region. Earlier published records (e.g. Collins, 1917; Conover & Sieburth, 1964; Farlow, 1914; Hentschell, 1921; Pratt, 1935; Winge, 1923) of green and red algae and of brown algae other than *Sargassum* from the Sargasso Sea are few and fragmentary, and, with one or two exceptions, they do not include identifications to species level.

Nearly 75 percent of the taxa encountered during this investigation have not been reported previously from the Sargasso Sea, and these new records raise the total known flora of the region to include 10 Chlorophyceae, 25 Phaeophyceae, and 33 Rhodophyceae. Epibiotic Bacillariophyceae (see Carpenter, 1970) and epibiotic Cyanophyceae (see Carpenter, 1972; Hentschell, 1921) are not treated in this paper.

Methods of sampling and processing are outlined elsewhere (Woelkerling, 1973); voucher material (with specimen numbers prefaced by WJW) has been retained in the author's personal collections, currently housed at WIS. Other herbarium abbreviations follow Lanjouw & Stafleu (1964).

Data provided for each taxon includes references to records of occurrence in adjacent regions and/or of general taxonomic value, the type locality and reported location of the type collection (in most cases, location of types has not been verified), known distribution based on published records, and collection data for all specimens examined. This information usually is followed by ecological and/or taxonomic notes. In cases where specific identification has not been possible due to fragmentary and/or very young or small plants, the available data has been summarized briefly at the generic level. The genus *Sargassum* presents special problems regarding species identification, and these are outlined in the discussion of that taxon.

Epibiotic taxa can be divided conveniently into two ecological groups, namely the permanent element and the invading element. The former includes all taxa epibiotic on *Sargassum fluitans* and/or *S. natans*, the two brown algae which comprise the vast bulk of Sargasso Sea vegetation, estimated by Parr (1939) to be in excess of 4×10^3 metric tons. These two species apparently are endemic to the Sargasso Sea. The invading element includes all other "macroscopic" taxa (*Ascophyllum*, *Fucus* and their associated epiphytes (Woelkerling, 1972), species of *Sargassum* other than *S. fluitans* and *S. natans*, etc.).

The permanent epibiotic element comprises both taxa which are normally of small size (less than 1 cm tall) and diminutive forms of taxa normally of larger stature. Species in both groups, however, frequently bear reproductive structures, in marked contrast to *Sargassum fluitans* and *S. natans* which never have been found with receptacles (see, however, Parr, 1939, page 49) and reproduce solely by fragmentation as far as is known.

Sincere thanks are due Mr. Gordon Volkmann of the Woods Hole Oceanographic Institution for making arrangements for the collection of samples in the Sargasso Sea and for making passage possible for the author on one of the cruises. Thanks are also due Dr. Elizabeth M. Gordon for examining collections of the Ceramiaceae.

DIVISION CHLOROPHYTA

CLASS CHLOROPHYCEAE

ORDER TETRASPORALES

Family Palmellaceae

Genus *Pseudotetraspora* Wille, 1906

Pseudotetraspora marina Wille 1906:20, Taf. 1, Figs. 32-36.

TYPE LOCALITY: Steinviksholm, Drontheimsfjord, Norway.

TYPE: not located.

DISTRIBUTION: apparently known only from the Sargasso Sea and Norway.

SPECIMENS EXAMINED: **Sargasso Sea:** 31°N-70°W, 5.vii.1970, *Volkmann* (WJW 2735); 32°09′N-64°58′W, 16.v.1970, *Woelkerling* (WJW 2670); 34°N-70°W, 30.vi.1970, *Volkmann* (WJW 2727), 6.vii.1970, *Volkmann* (WJW 2748); 35°54′N-70°30′W, 13.viii.1970, *Moore* (WJW 2901); 37°N-70°W, 12.v.1970, *Woelkerling* (WJW 2625); 37°30′N-70°W, 8.vii.1970, *Volkmann* (WJW 2708); 39°07′N-70°35′W, 16.viii.1970, *Moore* (WJW 2919, 2927); 39°30′N-71°W, 6.x.1970, *Volkmann* (WJW 2871).

The small, amorphous, gelatinous thalli have been found as epiphytes on *Sargassum natans*, *Sargassum* sp., and *Cladophora*.

Howe (1920) described a *Pseudotetraspora antillarum* from the Bahamas and separated it from *P. marina* on the basis of apparent differences in color, shape of the gelatinous mass, and cell size. These criteria require further consideration since the Sargasso Sea specimens could conveniently be placed in either taxon. Howe (1920), for example, lists cell diameters of 3-7 μm for *P. antillarum* while Wille (1906) gives cell diameter of 4-10 μm for *P. marina*. The Sargasso Sea plants have cell diameters of 3-14 μm. A critical comparison of the types and other collections of the two taxa may well show them to be conspecific.

ORDER CHAETOPHORALES

Family Chaetopeltidaceae

Genus *Diplochaete* Collins, 1901

Diplochaete solitaria Collins 1901:242. Chapman 1961:69, Fig. 73. Collins 1909:278, Fig. 99. Collins and Hervey 1917:38. Taylor 1960:53.

TYPE LOCALITY: Kingston, Jamaica.

TYPE: NY.

DISTRIBUTION: Bermuda, Jamaica, Sargasso Sea.

SPECIMENS EXAMINED: **Sargasso Sea:** 26°57′N-72°58′W, 26.iv.1970, *Moore* (WJW 2647, 2651); 28°N-70°W, 4.iii.1970, *Volkmann* (WJW 2435); 31°N-70°W, 5.vii.1970, *Volkmann* (WJW 2734); 32°09′N-64°58′W, 16.v.1970, *Woelkerling* (WJW 2664, 2668); 34°N-70°W, 30.vi.1970, *Volkmann* (WJW 2726, 2747); 35°54′N-70°30′W, 13.viii.1970, *Moore* (WJW 2900); 36°28′N-70°29′W, 15.viii.1970, *Moore* (WJW 2908); 37°N-70°W, 12.v.1970, *Woelkerling* (WJW 2618); 38°22′N-70°58′W, 12.x.1970, *Volkmann* (WJW 2891); 39°07′N-70°35′W, 16.viii.1970, *Moore* (WJW 2916); 39°30′N-71°W, 6.x.1970, *Volkmann* (WJW 2860, 2885).

This species appears to be a rather common component of the Sargasso Sea flora and has been found, sometimes in considerable numbers, on both *Sargassum fluitans* and *S. natans* as well as on a variety of red algae, *Cladophora* (Chlorophyta), and on hydroids.

Cells in the collections examined bear 1-4 setae that may be oriented in any direction relative to one another but generally are directed away from the substrate. As noted by Collins (1909) the freshwater taxa often referred to the genus *Polychaetophora* West and West (1903) may be congeneric with *Diplochaete* (see also Printz, 1964; G. S. West, 1908).

ORDER ULVALES

Family Ulvaceae

Genus *Enteromorpha* Link, 1820

Enteromorpha sp.

Two collections [31°N-69°29′W, 3.iii.1970, *Volkmann* (WJW 2369) and 34°N-70°W, 7.iii.1970, *Volkmann* (WJW 2397)] of *Sargassum fluitans* contained epiphytic plants

of *Enteromorpha* which appear similar to *E. flexuosa* (Wulfen ex Roth) J. Agardh (see Bliding, 1963, for a detailed account of *E. flexuosa*). Since the Sargasso Sea plants were all stunted (under 3 cm tall), however, specific determination could not be made with certainty.

Genus *Monostroma* Thuret, 1854

Monostroma pulchrum Farlow 1881:41. Collins 1909:211. Collins, Holden, and Setchell 1900:658. Taylor 1957:72.

TYPE LOCALITY: Watch Hill, Connecticut.

TYPE: FH.

DISTRIBUTION: Connecticut to Nova Scotia, Sargasso Sea.

SPECIMENS EXAMINED: **Sargasso Sea:** 39°05′N-69°48′W, 10.v.1970, *Woelkerling* (WJW 2572); 39°11′N-69°24′W, 10.v.1970, *Woelkerling* (WJW 2550).

Two small plants of *Monostroma pulchrum* were found as epiphytes on *Fucus vesiculosus* L., which had apparently drifted out into the Northwestern fringes of the Sargasso Sea (see Woelkerling, 1972). Critical studies are needed to determine whether *M. pulchrum* is really specifically distinct from the more widely distributed and better known *M. oxyspermum* (Kuetzing) Doty (see Bliding, 1968, p. 585, under *Ulvaria oxysperma*).

Genus *Percursaria* Bory, 1823

Percursaria percursa (C. Agardh) Rosenvinge 1893:963. Bliding 1963:20, Figs. 5-6. Collins 1909:197. Kylin 1949:16, Fig. 9. Taylor 1957:61; 1960:54.

Enteromorpha percursa (C. Agardh) J. Agardh Chapman 1961:66, Fig. 70.

TYPE LOCALITY: Adriatic Sea.

TYPE: LD.

DISTRIBUTION: widely distributed.

SPECIMENS EXAMINED: **Sargasso Sea:** 34°N-70°W, 13.v.1970, *Woelkerling* (WJW 2612); 37°N-70°W, 12.v.1970, *Woelkerling* (WJW 2627).

In both cases the host plant was *Sargassum natans*. The main axes and laterals were pleuriseriate while the smaller laterals were uniseriate in the specimens examined.

Genus *Ulva* Linneaus, 1753

Ulva sp.

One young plant [34°N-70°W, 7.iii.1970, *Volkmann* (WJW 2412)] of *Ulva* was found as an epiphyte on a fragment of the grass *Spartina*. Specific determination was not possible. The *Spartina* fragment apparently had drifted out from the U. S. coast.

ORDER CLADOPHORALES

Family Cladophoraceae

Genus *Cladophora* Kuetzing, 1843

As noted by Taylor (1960, p. 78), the genus *Cladophora* has been difficult to cope with in the American tropics and critical studies are badly needed. The recent monographs of Soderstrom (1963) and van den Hoek (1963), which will probably provide a basis for such studies, have been used in making specific determinations during this investigation.

Cladophora dalmatica Kuetzing 1843:263. van den Hoek 1963:186, Figs. 601-35.

C. oblitterata Soderstrom 1963:47, Figs. 38-54A.

TYPE LOCALITY: Split (Spalato), Yugoslavia.

TYPE: L (No. 937/281/406).

DISTRIBUTION: probably widespread.

SPECIMENS EXAMINED: **Sargasso Sea:** 26°57′N-72°58′W, 26.iv.1970, *Moore* (WJW 2646); 31°N-69°29′W, 3.iii.1970, *Volkmann* (WJW 2374); 34°N-70°W, 10.i.1970, *Volkmann* (WJW 2205), 13.v.1970, *Woelkerling* (WJW 2614); 37°N-70°W, 12.v.1970, *Woelkerling* (WJW 2620); 37°30′N-70°W, 8.vii.1970, *Volkmann* (WJW 2704); 38°22′N-70°58′W, 12.x.1970, *Volkmann* (WJW 2886); 39°07′N-70°35′W, 16.viii.1970, *Moore* (WJW 2918).

Specimens up to 3 cm tall have been found both on *Sargassum fluitans* and *S. natans*. In all cases the apical cells were under 20 μm in diameter and the branch systems showed a distinct acropetal organization.

Cladophora laetevirens (Dillwyn) Kuetzing 1843:267. van den Hoek 1963:128, Figs. 409-429, 433, 440.

TYPE LOCALITY: England.

NEOTYPE: BM (H4351/60/6); see van den Hoek 1963; p. 128.

DISTRIBUTION: probably widespread.

SPECIMEN EXAMINED: **Sargasso Sea:** 31°N-69°29′W, 3.iii.1970, *Volkmann* (WJW 2359).

The only specimen (about 2.5 cm tall) encountered during this study occurred as an epiphyte on *Sargassum fluitans*.

Cladophora socialis Kuetzing 1849:416, 1854:15, pl. 71, Fig. 1. van den Hoek 1963:43, Figs. 79-91.

TYPE LOCALITY: Tahiti.

TYPE: L (937/253/440).

DISTRIBUTION: Europe, Tropical Oceania, Sargasso Sea.

SPECIMEN EXAMINED: **Sargasso Sea:** 26°57′N-72°58′W, 26.iv.1970, *Moore* (WJW 2650).

The plants, up to 2 cm tall, occurred as epiphytes on *Sargaassum natans*.

Genus *Spongomorpha* Kuetzing, 1843

Spongomorpha arcta (Dillwyn) Kuetzing 1849:417. Collins 1909:359. Taylor 1957:90, pl. 6, Figs. 5-6.

Cladophora arcta (Dillwyn) Kuetzing 1843:263. Collins, Holden and Setchell 1896:224; 1901:815.

TYPE LOCALITY: England.

TYPE: presumably in NMW.

DISTRIBUTION: colder waters of Europe and North America.

SPECIMENS EXAMINED: **Sargasso Sea:** 38°53′N-69°39′W, 10.v.1970, *Woelkerling* (WJW 2561, 2567); 39°05′N-69°48′W, 10.v.1970, *Woelkerling* (WJW 2571).

Specimens up to 2 cm tall were found attached to plants of *Ascophyllum nodosum* and *Fucus vesiculosus* which had drifted out to the Northwestern fringes of the Sargasso Sea (see Woelkerling 1972). *Spongomorpha arcta* is probably not a permanent component of the Sargasso Sea flora.

DIVISION CHROMOPHYTA
CLASS PHAEOPHYCEAE
ORDER ECTOCARPALES
Family Ectocarpaceae

Genus *Ectocarpus* Lyngbye, 1819

Ectocarpus elachistaeformis Heydrich 1892:470, pl. XXV, Fig. 14. Boergesen 1914:18, Fig. 11; 1920:435. Collins and Hervey 1917:70. Earle 1969:132, Fig. 28. Taylor 1928:107, pl. 14, Fig. 12; 1960:202, pl. 29, Fig. 9.

TYPE LOCALITY: New Guinea.

TYPE: probably destroyed.

DISTRIBUTION: Caribbean Islands, Gulf of Mexico, New Guinea, Sargasso Sea.

SPECIMENS EXAMINED: **Sargasso Sea:** 31°N-69°29′W, 3.iii.1970, *Volkmann* (WJW 2382, 2384); 34°N-70°W, 10.i.1970, *Volkmann* (WJW 2211).

Plants up to 5 mm tall occurred as epiphytes on *Sargassum natans* and on an unidentified *Sargassum* sp. Plurilocular organs are relatively abundant but are not as elongate-lanceolate as described by Boergesen (1914).

Genus *Feldmannia,* Hamel, 1939

Feldmannia irregularis (Kuetzing) Hamel 1931-1939:XVII, Fig. 61F. Cardinal 1964:54, Fig. 29. Kuckuck 1963:371, Fig. 6.

Ectocarpus irregularis Kuetzing. Boergesen 1926:25, Figs. 12-14. Chapman 1963:11. Rosenvinge et Lund 1941:50, Figs. 23-24. Sauvageau 1933:101, Figs. 24-27.

TYPE LOCALITY: Adriatic Sea.

TYPE: L.

DISTRIBUTION: northern Europe, Canary Islands, Sargasso Sea.

SPECIMENS EXAMINED: **Sargasso Sea:** 28°N-70°W, 4.iii.1970, *Volkmann* (WJW 2431); 31°N-60°29′W, 3.iii.1970, *Volkmann* (WJW 2366); 34°N-70°W, 7.iii.1970, *Volkmann* (WJW 2413).

The Sargasso Sea specimens occur as epiphytes on *Sargassum fluitans* and *S. natans* and agree well with the account of *Feldmannia irregularis* given by Cardinal (1964). Plurilocular sporangia are common. Chapman (1963) records this taxon (as *Ectocarpus irregularis*) from Jamaica and, following Boergesen (1941), regards *E. rallsiae* (= *Giffordia rallsiae* (Vickers) Taylor (1960, p. 208), a widely distributed taxon in the American tropics) as conspecific. Earle (1969), however, maintains *G. rallsiae* as a distinct species. The precise relationships of *G. rallsiae* and *Feldmannia irregularis* thus remain uncertain and further critical studies of the type and other collections of the two taxa are needed.

Genus *Giffordia* Batters, 1893

Giffordia conifera (Boergesen) Taylor 1960:207. Earle 1969:135, Fig. 21.

Ectocarpus coniferus Boergesen 1914:8, Figs. 5, 6. Collins and Hervey 1917:69.

TYPE LOCALITY: U. S. Virgin Islands.

TYPE: C.

DISTRIBUTION: Sargasso Sea and tropical western Atlantic.

SPECIMENS EXAMINED: **Sargasso Sea:** 28°N-70°W, 4.iii.1970, *Volkmann* (WJW 2430); 34°N-70°W, 7.iii.1970, *Volkmann* (WJW 2416).

The Sargasso Sea specimens occur epiphytically on *Sargassum fluitans* and *S. natans* and agree with the original account of Boergesen (1914). Only plurilocular sporangia are present. Hamel (1931-39) considers this taxon to be conspecific with *Feldmannia irregularis*, but Earle (1969) maintains it as a distinct species. The status of the taxon will remain questionable until a critical study of all the ectocarpoid algae of the western tropical Atlantic is undertaken.

Giffordia mitchelliae (Harvey) Hamel 1939:XIV, Fig. 61c, d. Cardinal 1964:45, Fig. 23. Earle 1969:138, Fig. 24. Taylor 1960:206, pl. 29. Figs. 1-2.

Ectocarpus mitchelliae Harvey 1852, p. 142, pl. 12 g. Boergesen 1914:6, Figs. 3-4. 1941:7, Figs. 1-5. Collins and Hervey 1917:69.

TYPE LOCALITY: Nantucket Island, Massachusetts.

TYPE: TCD.

DISTRIBUTION: widespread in tropical and temperate seas.

SPECIMENS EXAMINED: **Sargasso Sea:** 31°N-69°29′W, 3.iii.1970, *Volkmann* (WJW 2361, 2381, 2383); 32°09′N-64°58′W, 16.v.1970, *Woelkerling* (WJW 2666); 34°N-70°W, 10.i.1970, *Volkmann* (WJW 2206, 2218); 39°07′N-70°35′W, 16.viii.1970, *Moore* (WJW 2925).

Specimens up to 5 cm tall occur as epiphytes on *Sargassum fluitans*, *S. natans*, and on an unidentified species of *Sargassum*. In all cases plurilocular sporangia are abundant.

Giffordia sandriana (Zanardini in Kuetzing) Hamel 1939: XIV. Cardinal 1964:37, Fig. 18. Kylin 1947:10, Fig. 3. Taylor 1960:207.

Ectocarpus sandrianus Zanardini in Kuetzing 1849:451. Rosenvinge et Lund 1941:44, Fig. 18.

TYPE LOCALITY: Adriatic Sea.

TYPE: L.

DISTRIBUTION: Bermuda, Europe, Sargasso Sea.

SPECIMENS EXAMINED: **Sargasso Sea:** 34°N-70°W, 7.iii.1970, *Volkmann* (WJW 2414).

Plants up to 5 cm tall occurred as epiphytes on *Sargassum fluitans* and bore plurilocular sporangia.

Genus *Pylaiella* Bory, 1823

Pylaiella littoralis (L.) Kjellman. Cardinal 1964:11, Fig. 1. Rosenvinge et Lund 1941:5. Taylor 1957:102, pl. 9, Figs. 1-3. Woelkerling 1972:298.

TYPE LOCALITY: Europe.

TYPE: LINN.

DISTRIBUTION: widespread.

SPECIMENS EXAMINED: **Sargasso Sea:** 38°53′N-69°39′W, 10.v.1970, *Woelkerling* (WJW 2559); 39°11′N-69°24′W, 10.v.1970, *Woelkerling* (WJW 2555).

The plants were found as epiphytes on *Fucus vesiculosus* along the northwest fringes of the Sargasso Sea and probably should not be considered as a permanent component of the Sargasso Sea flora (Woelkerling, 1972).

ORDER SPHACELARIALES
Family Sphacelariaceae

Genus *Sphacelaria* Lyngbye, 1819

Sphacelaria fucigera Kuetzing. Sauvageau 1901:145, Fig. 35. Taylor 1960:210, pl. 29, Fig. 5. Womersley 1967:199.

TYPE LOCALITY: Karak Island, Persian Gulf.

TYPE: L (937/71/472).

DISTRIBUTION: cosmopolitan in tropical and temperate waters.

SPECIMENS EXAMINED: **Sargasso Sea:** 34°N-70°W, 10.i.1970, *Volkmann* (WJW 2202); 38°22′N-70°58′W, 12.x.1970, *Volkmann* (WJW 2896); 39°07′N-70°35′W, 16.viii.1970, *Moore* (WJW 2921).

The plants were epiphytic on *Sargassum natans* and an unidentified *Sargassum* and bore numerous propagula. One collection (WJW 2921) also had numerous multicellular hairs.

ORDER DICTYOTALES
Family Dictyotaceae

Genus *Dictyota* Lamouroux, 1809

Dictyota sp.

Two collections [32°09′N-64°58′W, 16.v.1970, *Woelkerling* (WJW 2658) and 39°30′N-71°W, 6.x.1970, *Volkmann* (WJW 2877)] of small plants referrable to *Dictyota* have been made during this study. The former, which contained both male and female reproductive structures and was about 5 cm tall, was found growing on a fragment of *Colpomenia*, which probably became detached and drifted out from the shores of Bermuda. It apparently shares a number of features with *D. dichotoma*, but definite specific determination was not considered possible.

The latter plants were attached to a fertile piece of *Sargassum* (origin uncertain) and were very young (less than 2 cm tall); specific determination likewise could not be made. It seems more probable that *Dictyota* is an invader rather than a permanent component of the Sargasso Sea flora considering that both host plants themselves appear to be invaders.

Prat (1935, p. 128) makes mention of a *Dictyota cervicornis* from this region, but no specimens referrable to that species have been encountered during the present study.

Genus *Padina* Adanson, 1763

Padina sp.

A very young *Padina* plant [32°09′N-64°58′W, 16.v.1970, *Woelkerling* (WJW 2657)] occurred on a piece of *Colpomenia* which apparently had drifted out from Bermuda. Specific determination was not possible and it seems probable that *Padina* is an invader rather than a permanent component of the Sargasso Sea flora.

ORDER CHORDARIALES
Family Elachisteaceae

Genus *Elachistea* Duby, 1830

Elachistea lubrica Ruprecht. Collins, Holden, and Setchell 1898:480. Taylor 1957:140. Woelkerling 1972:297.

TYPE LOCALITY: Okhotsk Sea.

TYPE: LE.

DISTRIBUTION: reported from eastern North America, Greenland, and the Okhotsk Sea.

SPECIMENS EXAMINED: **Sargasso Sea:** 38°53′N-69°39′W, 10.v.1970, *Woelkerling* (WJW 2564); 39°05′N-69°48′W, 10.v.1970, *Woelkerling* (WJW 2569); 39°11′N-69°24′W, 10.v.1970, *Woelkerling* (WJW 2547; 2556).

An invader species attached to drifting *Ascophyllum* and *Fucus* (see Woelkerling, 1972). The specimens have been referred to *Elachistea lubrica* because of the apparent absence of moniliform paraphyses (see Taylor, 1957, p. 139),

but critical study is needed to determine whether this is a reliable character of specific distinction. Lund (1959) and Rosenvinge (1893) have regarded *E. lubrica* as a variety of *E. fucicola*.

Family Chordariaceae

Genus *Chordaria* C. Agardh, 1817

Chordaria flagelliformis (Mueller) C. Agardh. Kylin 1947: 59, Figs. 51A, D. Lund 1959:121, Figs. 26, 27. Taylor 1957:148, pl. 12, Fig. 6; pl. 14, Fig. 4.

TYPE LOCALITY: Denmark.

TYPE: not located.

DISTRIBUTION: cooler waters of North America and Europe.

SPECIMENS EXAMINED: **Sargasso Sea:** 39°05′N-69°48′W, 10.v.1970, *Woelkerling* (WJW 2576); 39°11′N-69°24′W, 10.v.1970, *Woelkerling* (WJW 2554).

The plants were epiphytes on invading specimens of *Fucus* (see Woelkerling, 1972) and are not considered permanent components of the Sargasso Sea flora.

ORDER PUNCTARIALES

Family Punctariaceae

Genus *Colpomenia* Derbes and Solier, 1856

Colpomenia sinuosa (Roth) Derbes and Solier. Taylor 1928: 110, pl. 7, Fig. 1, pl. 19, Figs. 3-4; 1960:260, pl. 36, Fig. 1. Womersley 1967:244.

TYPE LOCALITY: Cadiz, Spain.

TYPE: probably lost.

DISTRIBUTION: widespread.

SPECIMEN EXAMINED: **Sargasso Sea:** 32°09′N-64°58′W, 16.v.1970, *Woelkerling* (WJW 2655).

The plant collected almost certainly drifted out into Sargasso Sea waters from Bermuda and does not represent a permanent component of the flora.

Genus *Petalonia* Derbes and Solier, 1850

Petalonia fascia (Mueller) Kuntze. Lund 1947:31, Fig. 10. Taylor 1957:167, pl. 14, Fig. 5; pl.15, Fig. 3.

Ilea fascia (Mueller) Fries. Kylin 1947:77, Fig. 61A.

TYPE LOCALITY: Denmark.

TYPE: not located.

DISTRIBUTION: widespread.

SPECIMEN EXAMINED: **Sargasso Sea:** 39°11′N-69°24′W, 10.v.1970, *Woelkerling* (WJW 2549).

This taxon is an invading element attached to *Fucus vesiculosus* (see Woelkerling, 1972).

Genus *Punctaria* Greville, 1830

Punctaria latifolia Greville. Collins, Holden, and Setchell 1895:82; 1901:873; 1907:1388. Taylor 1957:166, pl. 15, Fig. 5.

TYPE LOCALITY: Great Britain.

TYPE: not located.

DISTRIBUTION: widespread.

SPECIMEN EXAMINED: **Sargasso Sea:** 39°05′N-69°48′W, 10.v.1970, *Woelkerling* (WJW 2573).

A single, rather small and battered plant was found attached to an invading *Fucus* element (see Woelkerling, 1972).

Punctaria plantaginea (Roth) Greville. Rosenvinge et Lund 1947:11, Fig. 2; 1959:133, Fig. 28. Taylor 1957:166, pl. 15, Fig. 4; pl. 16, Fig. 4.

TYPE LOCALITY: Kattegat Channel between Denmark and Sweden.

TYPE: probably destroyed.

DISTRIBUTION: widespread.

SPECIMENS EXAMINED: **Sargasso Sea:** 38°53′N-69°39′W, 10.v.1970, *Woelkerling* (WJW 2560); 39°05′N-69°48′W, 10.v.1970, *Woelkerling* (WJW 2575).

Two small plants occurred as epiphytes on *Fucus*; they are not considered permanent components of the Sargasso Sea flora (see Woelkerling, 1972).

Genus *Scytosiphon* C. Agardh, 1811

Scytosiphon lomentaria (Lyngbye) C. Agardh. Rosenvinge et Lund 1947:27, Fig. 9; 1959:103, Fig. 20. Taylor 1957: 168, pl. 15, Fig. 2; pl. 16, Fig. 3.

TYPE LOCALITY: Denmark.

TYPE: C.

DISTRIBUTION: nearly cosmopolitan.

SPECIMENS EXAMINED: **Sargasso Sea:** 38°53'N-69°39'W, 10.v.1970, *Woelkerling* (WJW 2562); 39°05'N-69°48'W, 10.v.1970, *Woelkerling* (WJW 2574); 39°11'N-69°24'W, 10.v.1970, *Woelkerling* (WJW 2548).

These collections occurred as epiphytes on *Fucus* and probably do not represent permanent components of the Sargasso Sea flora. The species does, however, occur in Bermuda and along the southeastern U. S. Coast (Taylor, 1960), and may eventually be found to occur on *Sargassum fluitans* or *S. natans* in the Sargasso Sea.

Family Striariaceae

Genus *Isthmoplea* Kjellman, 1877

Isthmoplea sphaerophora (Harvey in Hooker) Kjellman. DeToni 1895:569. Kylin 1947:67, Figs. 56D-E. Taylor 1957:156, pl. 9, Figs. 4-5. Woelkerling 1972:298.

Ectocarpus sphaerophorus Carmichael. Harvey 1846: pl. CXXVI.

TYPE LOCALITY: Appin, Scotland.

TYPE: TCD.

DISTRIBUTION: cooler waters of Eastern North America and Europe.

SPECIMEN EXAMINED: **Sargasso Sea:** 38°53'N-69°39'W, 10.v.1970, *Woelkerling* (WJW 2566).

The single collection contains a number of fertile plants attached to *Polysiphonia lanosa*, in turn an epiphyte on a plant of *Ascophyllum*, which had drifted out into the Northwestern fringes of the Sargasso Sea (see Woelkerling, 1972).

ORDER FUCALES

Family Fucaceae

Genus *Ascophyllum* Stackhouse 1809

Ascophyllum nodosum (L.) Le Jolis. Kylin 1947:84. Taylor 1957:195, pl. 27, Figs. 1-2.

TYPE LOCALITY: Atlantic Ocean.

TYPE: LINN.

DISTRIBUTION: widespread in colder waters of the northern hemisphere.

SPECIMENS EXAMINED: **Sargasso Sea:** 38°53′N-69°39′W, 10.v.1970, *Woelkerling* (WJW 2558); 39°05′N-69°48′W, 10.v.1970, *Woelkerling* (WJW 2568); 39°11′N-69°24′W, 10.v.1970, *Woelkerling* (WJW 2546).

The plants were found adrift along the northwest fringes of the Sargasso Sea; there is some question as to whether they should be regarded as permanent components of the Sargasso Sea flora (see Woelkerling, 1972).

Genus *Fucus* Linneaus, 1753

Fucus vesiculosus L. Harvey 1852:71. Kylin 1947:83, Tab. 17, Figs. 53-54. Taylor 1957:192, pl. 25, Figs. 1-3.

TYPE LOCALITY: Atlantic Ocean.

TYPE: LINN.

DISTRIBUTION: widespread in colder waters of northern hemisphere.

SPECIMENS EXAMINED: **Sargasso Sea:** 38°53′N-69°39′W, 10.v.1970, *Woelkerling* (WJW 2563); 39°05′N-69°48′W, 10.v.1970. *Woelkerling* (WJW 2570); 39°11′N-69°24′W, 10.v.1970, *Woelkerling* (WJW 2557).

The plants were found adrift along the northwest fringes of the Sargasso Sea with *Ascophyllum* and *Sargassum natans* and bore a number of epiphytes (see Woelkerling, 1972).

Family Sargassaceae

Genus *Sargassum* C. Agardh, 1820

The tropical American Atlantic species of *Sargassum* are poorly known and specific limits and distinctions remain

very unclear (see Taylor, 1960, p. 268). Moreover, keys to species occurring in this region (e.g. Howe, 1920; Taylor, 1928, 1960) are based largely on vegetative features rather than on reproductive structures, which appear to be of more fundamental significance (Setchell, 1931; Womersley, 1954). The situation is further complicated by the fact that the two species of *Sargassum* most commonly found in the Sargasso Sea apparently have never been found in a fertile state (see, however, Parr, 1939).

During the course of this study, seven apparently distinct species of *Sargassum* have been found adrift in the western Sargasso Sea. Only three of these, however, have been identified with any certainty. The remaining four have not been definitely identified as yet and, following the approach of Winge (1923), are referred to here as *Sargassum* A, B, etc., to avoid further name confusion until such time as a critical monographic study of the genus is undertaken for this region.

Differences between the seven taxa are summarized as follows:

Conspectus of *Sargassum* Taxa in the Western Sargasso Sea

1. Plants sterile, pelagic, without evidence of a basal holdfast. . . . . 2.
   2. Stems smooth; vesicles often apiculate; leaves linear, up to 4 mm wide. . . . . *S. natans*.
   2. Stems muriculate; vesicles at most muticous; leaves lanceolate, up to 8 mm wide. . . . . *S. fluitans*.
1. Plants commonly fertile, normally attached, usually showing evidence of a holdfast. . . . . 3.
   3. Fruiting branches often carpophyllaceous (i.e. of mixed receptacles, leaves, and vesicles). . . . . 4.
      4. Receptacles pedicellate; cryptostomata tending to be in a single row adjacent to the costa. . . . . "*Sargassum* D."

4. Receptacles not pedicellate; cryptostomata scattered. ..... *"Sargassum* B."

3. Fruiting branches not carpophyllaceous (i.e. composed solely of receptacles). ..... 5.

5. Receptacles pedicellate. ..... 6.

6. Receptacles commonly spiny; costa not spiny or dentate. ..... *Sargassum hystrix* var. *buxifolium.*

6. Receptacles not spiny; costa prominently dentate to spiny. ..... *"Sargassum* A."

5. Receptacles sessile. ..... *"Sargassum* C."

Sargassum fluitans (Boergesen) Boergesen 1914a:6. Taylor 1928:127, pl. 18, Fig. 9; pl. 19, Fig. 5; 1960:281, pl. 39, Fig. 2, pl. 40, Fig. 7.

Sargassum hystrix J. Ag. var. *fluitans* Boergesen 1914a: 11, Fig. 8. Winge 1923:23, Fig. 6 (as *"Sargassum* III").

TYPE LOCALITY: Sargasso Sea.

TYPE: C.

DISTRIBUTION: known only from the Sargasso Sea.

SPECIMENS EXAMINED: **Sargasso Sea:** 21°58′N-68°20′W, 24.iv.1970, *Moore* (WJW 2639); 26°57′N-72°58′W, 26.iv.1970, *Moore* (WJW 2649); 28°N-70°W, 4.vii.1970, *Volkmann* (WJW 2738); 31°N-69°29′W, 3.iii.1970, *Volkmann* (WJW 2394); 31°N-70°W, 5.vii.1970, *Volkmann* (WJW 2731); 32°09′N-64°58′W, 16.v.1970, *Woelkerling* (WJW 2654); 33°58′N-69°56′W, 15.v.1970, *Woelkerling* (WJW 2602); 34°N-70°W, 10.i.1970, *Volkmann* (WJW 2224), 7.iii.1970, *Volkmann* (WJW 2418), 6.vii.1970, *Volkmann* (WJW 2742), 14.viii.1970, *Moore* (WJW 2933); 36°N-70°36′W, 9.xii.1970, *Moore* (WJW 2947); 37°N-70°W, 12.v.1970, *Woelkerling* (WJW 2616); 37°30′N-70°W, 8.vii.1970, *Volkmann* (WJW 2712); 38°34′N-69°11′W, 19.v.1970, *Woelkerling* (WJW 2606).

Sargassum fluitans is the less frequently encountered of the two species of *Sargassum* endemic to the Sargasso Sea but apparently enjoys almost as wide a distribution. The specimens examined during this study were commonly covered with bryozoans and to a lesser extent with epibiotic algae.

Sargassum hystrix J. Agardh var. *buxifolium* (Chauvin) J. Agardh 1889:91, tab VII, Fig. 1. Boergesen 1914:221. Chapman 1963:45. Earle 1969:225, Fig. 118. Grunow 1915:399. Howe 1920:594. Taylor 1928:128, pl. 18, Fig. 1, pl. 19, Fig. 9; 1960:279, pl. 38, Fig. 2, pl. 40, Fig. 6.

TYPE LOCALITY: Caribbean Area (see DeToni 1895:53).

TYPE: LD(?).

DISTRIBUTION: Florida to Brazil, Caribbean Islands, Sargasso Sea.

SPECIMENS EXAMINED: **Sargasso Sea:** 36°N-70°36′W, 9.xii.1970, *Moore* (WJW 2912); 39°30′N-71°W, 6.x.1970, *Volkmann* (WJW 2873).

The specimens examined agree well with the descriptions and illustrations of Earle (1969) and Taylor (1960), and probably are the same as "*Sargassum* VI" of Winge (1923, p. 25, Fig. 10). The material was collected in the immediate vicinity of the Gulf Stream, the same region reported by Winge (1923), and apparently is known mainly from drift specimens (Earle, 1969; Taylor, 1928, 1960).

Both specimens bore non-carpophyllaceous receptacles which were simple or once funcate, terete or slightly compressed, verrucose or occasionally with odd spines, pedicellate, and more or less racemose.

Sargassum natans L. Boergesen 1914a:7, Figs. 3-7. Taylor 1928:128, pl. 18, Figs. 2-4, pl. 19, Fig. 13; 1960: pl. 37, Fig. 2, pl. 40, Figs. 3, 8. Winge 1923:24, Figs. 3-5 (as "Sargassum I & III").

TYPE LOCALITY: Sargasso Sea.

TYPE: LINN.

DISTRIBUTION: known only from the Sargasso Sea.

SPECIMENS EXAMINED: **Sargasso Sea:** 20°50′N-67°15′W, 24.iv.1970, *Moore* (WJW 2645); 21°58′N-68°20′W, 24.iv.1970, *Moore* (WJW 2640); 26°50′N-71°48′W, 5.iii.1970, *Volkmann* (WJW 2422); 26°57′N-72°58′W, 26.iv.1970, *Moore* (WJW 2653); 28°N-70°W, 4.iii.1970, *Volkmann* (WJW 2437), 4.vii.1970, *Volkmann* (WJW 2739), 31°N-69°29′W, 3.iii.1970, *Volkmann* (WJW 2393); 31°N-70°W, 5.vii.1970, *Volkmann* (WJW 2732); 32°09′N-64°58′W, 16.v.1970, *Woelkerling* (WJW 2662); 34°N-70°W, 10.i.1970, *Volkmann* (WJW 2223), 7.iii.

1970, *Volkmann* (WJW 2417), 13.v.1970, *Volkmann* (WJW 2607), 30.vi.1970, *Volkmann* (WJW 2723), 6.vii.1970, *Volkmann* (WJW 2743), 14.viii.1970, *Volkmann* (WJW 2931); 35°54′N-70°30′W, 13.viii. 1970, *Moore* (WJW 2904); 36°N-70°36′W, 9.xii.1970, *Moore* (WJW 2950); 36°28′N-70°29′W, 15.viii.1970, *Moore* (WJW 2905); 37°N-70°W, 12.v.1970, *Woelkerling* (WJW 2617); 37°30′N-70°W, 8.vii.1970, *Woelkerling* (WJW 2711); 38°22′N-70°58′W, 12.x.1970, *Volkmann* (WJW 2897); 38°34′N-69°11′W, 19.v.1970, *Woelkerling* (WJW 2605); 39°07′N-70°35′W, 16.viii.1970, *Moore* (WJW 2909); 39°11′N-69°24′W, 10.v.1970, *Woelkerling* (WJW 2644).

Sargassum natans plants comprise the vast bulk of the Sargasso Sea macroscopic vegetation, estimated by Parr (1939) to be up to 40 million metric tons. It also harbored the greatest variety and quantity of epibiotic algae. The considerable quantities of *S. natans* which wash up on the shores of Bermuda, in contrast, are apparently devoid of epiphytes (Woelkerling, personal observations).

"*Sargassum* A"

The single specimen [39°30′N-70°W, 6.x.1970, *Volkmann* (WJW 2867)] referred to this "taxon" bears a small, discoid holdfast and a sparsely branched, nearly terete main axis with a few, scattered, long laterals whose stems are muriculate. The leaves are lanceolate, up to 3 mm broad and 30 mm long, finely serrate, with a prominent dentate to spiny costa. Cryptostomata are lacking. Vesicles up to 5 mm in diameter are mostly single and pedicellate and scattered among the leaves.

The receptacles are not carpophyllaceous, and are simple or up to several times furcate, terete, verrucose, not spiny or dentate, pedicellate, racemose, and up to 10 mm long.

While these features are most closely associated with *Sargassum filipendula* var. *montagnei* as described in Taylor (1960), definite specific affiliation of the specimen in question remains uncertain.

"*Sargassum* B"

The single specimen [34°N-70°W, 10.i.1970, *Volkmann* (WJW 2222)] lacks a holdfast and has a smooth stem with a number of short lateral branches. The leaves are mostly

lanceolate ovate, up to 5 mm broad and 30 mm long, serrate, have costae without ridges or wings and bear scattered cryptostomata. Vesicles up to 6 mm broad are short pedicellate and are scattered among the leaves and receptacles.

The receptacles are generally carpophyllaceous and usually 2-4 times furcate, are terete, not dentate or spiny, are not pedicellate and are borne in dense cymose clusters.

Although this taxon shows many of the features of *Sargassum vulgare* C. Agardh as described in Taylor (1960), final specific identification remains uncertain.

"*Sargassum* C"

The single specimen [33°58.5′N-69°56.5′W, 15.v.1970, *Woelkerling* (WJW 2589)] lacks a holdfast and has muriculate stems bearing lateral branches of variable length. The leaves are linear lanceolate, up to 3 mm broad and 30 mm long, entire or finely serrate, and bear inconspicuous costae and scattered cryptostomata. Shortly pedicellate vesicles up to 5 mm in diameter are scattered along the branches.

The receptacles generally are not carpophyllaceous, are one to several times furcate, terete, verrucose, generally not pedicellate, and are racemose.

This specimen could not be linked to any of the species described by Taylor (1960). In some respects it is similar to what Taylor (1960) calls *Sargassum filipendula* var. *montagnei*, but differs in the nature of the costa and in having non-pedicellate receptacles.

"*Sargassum* D"

The one specimen [34°N-70°W, 10.i.1970, *Volkmann* (WJW 2225)] lacks a holdfast and has a stem that is muriculate in the younger portions and smooth in the older portions. Lateral branches vary in length and bear lanceolate leaves up to 3 mm broad and 30 mm long which are mostly entire, costate, and bear cryptostomata which tend to lie in a single row on each side of the costa. Shortly pedicellate vesicles up to 5 mm in diameter are scattered along the lateral branches.

The receptacles are carpophyllaceous, simple or once furcate, terete, not dentate or spiny, pedicellate, and generally cymose.

Of the species described by Taylor (1960), this specimen most closely approximates *Sargassum acinarium* (L.) C. Agardh, but apparent differences in receptacle morphology leaves some doubt as to the specimen's true affinities.

A second specimen [37°N-70°W, 12.v.1970, *Woelkerling* (WJW 2673)] shares many features with "*Sargassum* D" including the linear distribution of cryptostomata, but the racemose nature of the receptacles leaves some doubt as to its exact relationships until further material becomes available for study.

CLASS RHODOPHYCEAE

SUBCLASS BANGIOPHYCIDAE

ORDER BANGIALES

Family Bangiaceae

Genus *Asterocytis* Gobi, 1879

Asterocytis ramosa (Twaites in Harvey) Gobi. Boergesen 1915:3, Fig. 1. Chapman 1963:49. Kylin 1944:6, Fig. 1d-f. Rosenvinge 1909:77, Fig. 17. Taylor 1928:132, pl. 20, Figs. 1-2; 1960:287. Wille 1900:7, Tab. 1, Figs. 8-14.

Hormospora ramosa Twaites in Harvey 1846-51:Pl. CCXII.

TYPE LOCALITY: Wareham, Dorsetshire, Great Britain.

TYPE: TCD.

DISTRIBUTION: widespread.

SPECIMENS EXAMINED: **Sargasso Sea:** 37°N-70°W, 12.v.1970, *Woelkerling* (WJW 3957); 39°07′N-70°35′W, 16.viii.1970, *Moore* (WJW 2920).

In both cases the plants were epiphytic on *Cladophora* which, in turn, was growing on *Sargassum natans*.

Hamel (1924), Boergesen (1927), and Pham Hoang-Ho (1969), among others, have referred this species to the synonomy of *Asterocystis ornata* (C. Agardh) Hamel.

Kylin (1944) and Taylor (1957, 1960), however, prefer to separate the two taxa on grounds that *A. ramosa* is marine and *A. ornata* freshwater. The validity of such a separation requires further investigation, and until new evidence comes to light, the two taxa will be kept distinct for purposes of the present study.

Genus *Erythrocladia* Rosenvinge, 1909

Erythrocladia subintegra Rosenvinge 1909:73, Figs. 13-14. Boergesen 1915:7, Figs. 3-4. Collins and Hervey 1917:95. Pham-Hoang-Ho 1969:80, Figs. 2-12. Taylor 1960:290.

TYPE LOCALITY: Hirshals, Skagerak, Denmark.

TYPE: C.

DISTRIBUTION: Europe, western tropical Atlantic, South-east Asia.

SPECIMENS EXAMINED: **Sargasso Sea:** 31°N-69°29′W, 3.iii.1970, *Volkmann* (WJW 2387, 2391, 2392); 34°N-70°W, 10.i.1970, *Volkmann* (WJW 2212), 7.iii.1970, *Volkmann* (WJW 2405, 2406); 36°N-70°36′W, 9.xii.1970, *Moore* (WJW 2939, 2940).

All specimens occurred as epiphytes on hydroids which, in turn, were growing on *Sargassum fluitans*, *S. natans*, or *Sargassum* sp.

Erythrocladia recondita Howe et Hoyt 1916:112, pl. 12, Figs. 1-5, pl. 13, Fig. 1. Hoyt 1920:467, pl. CXVI, Fig. 1, pl. CXVII, Figs. 1-5.

TYPE LOCALITY: Beaufort, North Carolina.

TYPE: NY.

DISTRIBUTION: type locality, Sargasso Sea.

SPECIMEN EXAMINED: **Sargasso Sea:** 39°30′N-71°W, 6.x.1970, *Volkmann* (WJW 2866).

The specimens occurred epizoically on hydroids which in turn grew on an unidentified *Sargassum*.

Genus *Erythrotrichia* Areschoug, 1850

Erythrotrichia carnea (Dillwyn) J. Agardh. Boergesen 1915:7. Collins and Hervey 1917:94. Hoyt 1920:466, Fig. 24. Rosenvinge 1909:67, Fig. 8. Taylor 1957:202, pl. 28, Figs. 13-15; 1960:292. Woelkerling 1972:298.

TYPE LOCALITY: Great Britain.
TYPE: NMW.
DISTRIBUTION: widespread.

SPECIMENS EXAMINED: **Sargasso Sea:** 28°N-70°W, 4.iii.1970, *Volkmann* (WJW 2433); 31°N-69°29′W, 3.iii.1970, *Volkmann* (WJW 2360; 2390); 34°N-70°W, 10.i.1970, *Volkmann* (WJW 2216), 7.iii.1970, *Volkmann* (WJW 2404); 39°11′N-69°24′W, 10.v.1970, *Woelkerling* (WJW 2551).

With the exception of the last cited specimen, all plants occurred epizoically on hydroids which in turn were attached to *Sargassum fluitans*, *S. natans*, or *Sargassum* sp. In the other collection, the plants occurred epiphytically on *Fucus* (Woelkerling, 1972).

Subclass Florideophycidae

order nemaliales

Family Acrochaetiaceae

Four species of *Audouinella* (*A. daviesii*, *A. hallandica*, *A. microscopica*, *A. saviana* [= *A. thuretii*]) and two species of *Colaconema* (*C. infestans*, *C. secundata*) occur in the western Sargasso Sea and are the subject of a recent detailed morphotaxonomic study (Woelkerling, 1973).

order cryptonemiales

Family Corallinaceae

Subfamily Corallineae

Genus *Jania* Lamouroux, 1812

Jania adherens Lamouroux. Boergesen 1917:195, Figs. 184-187. Chapman 1963:86, Fig. 85. Taylor 1928:205. Howe 1920:589. 1960:413, pl. 49, Figs. 1-2.
TYPE LOCALITY: Mediterranean Sea.
TYPE: not located.
DISTRIBUTION: widespread in tropical and warm temperate waters.

SPECIMEN EXAMINED: **Sargasso Sea:** 32°09′N-65°58′W, 16.v.1970, *Woelkerling* (WJW 2656).

The single collection occurred as an epiphyte on a plant of *Colpomenia* (q.v.) which probably drifted out from the

Bermuda Islands; consequently this species of *Jania* probably does not represent a permanent component of the Sargasso Sea flora.

Jania capillacea Harvey 1853:85. Boergesen 1917:198, Fig. 188. Chapman 1963:86, Fig. 86. Collins, Holden, and Setchell 1895:150. Howe 1920:589. Taylor 1928:206, pl. 29, Figs. 2, 10. 1960:413, pl. 49, Figs. 1-2.

TYPE LOCALITY: Bahia Honda, Florida.

TYPE: TCD.

DISTRIBUTION: tropical western Atlantic.

SPECIMENS EXAMINED: **Sargasso Sea:** 31°N-69°29′W, 3.iii.1970, *Volkmann* (WJW 2217); 36°N-70°36′W, 9.xii.1970, *Moore* (WJW 2945); 39°07′N-70°35′W, 16.viii.1970, *Moore* (WJW 2926).

Jania capillacea has been found growing on *Sargassum fluitans*, *S. natans*, and on several unidentified *Sargassum* taxa. Prat (1935) previously reported this taxon from the Sargasso Sea.

Subfamily Melobesieae

Genus *Fosliella* Howe, 1920

Fosliella farinosa (Lamouroux) Howe 1920:587. Chapman 1963:91, Fig. 92. Dawson 1960:30, pl. 21, Fig. 1, pl. 22, Fig. 1. Taylor 1960:388. Womersley and Bailey 1970: 309.

Melobesia farinosa Lamouroux. Lemoine in Boergesen 1917:170, Fig. 165. Hoyt 1920:523, Fig. 47. Taylor 1928:211.

TYPE LOCALITY: Adriatic Sea.

TYPE: CN.

DISTRIBUTION: nearly cosmopolitan.

SPECIMENS EXAMINED: **Sargasso Sea:** 31°N-69°29′W, 3.iii.1970, *Volkmann* (WJW 2355); 34°N-70°W, 13.v.1970, *Woelkerling* (WJW 2608).

The plants occurred epiphytically on *Sargassum fluitans* and *S. natans*.

Fosiella lejolisii (Rosanoff) Howe 1920:588. Masaki 1968: 23, pls. XII, XLIX, L. Taylor 1957:253, pl. 36, Figs. 6-8.

Melobesia lejolisii Rosanoff 1866:62, pl. 1, Figs. 1-13, pl. 7, Figs. 9-11. Rosenvinge 1917:238, Figs. 156-159.

TYPE LOCALITY: Cherbourg, France.

TYPE: not located.

DISTRIBUTION: Europe, Atlantic North America, Japan, Sargasso Sea.

SPECIMENS EXAMINED: **Sargasso Sea:** 28°N-70°W, 4.iii.1970, *Volkmann* (WJW 2436); 31°N-69°29′W, 3.iii.1970, *Volkmann* (WJW 2356, 2378); 32°09′N-64°58′W, 16.v.1970, *Woelkerling* (WJW 2659, 2672); 33°58.5′N-69°56.5′W, 15.v.1970, *Woelkerling* (WJW 2590, 2600); 34°N-70°W, 7.iii.1970, *Volkmann* (WJW 2400, 2402); 36°N-70°36′W, 9.xii.1970, *Moore* (WJW 2946, 2948); 37°N-70°W, 12.v.1970, *Woelkerling* (WJW 2634); 39°07′N-70°35′W, 16.viii.1970, *Moore* (WJW 2928).

Fosliella lejolesii occurs as an epiphyte on *Sargassum fluitans, S. natans, Sargassum* sp. as well as on other algae, and in terms of numbers of individuals, is probably the most common red alga in the Sargasso Sea. Only *Ceramium gracillimum* (q.v.) approaches the same quantitative frequency.

According to Taylor (1960, p. 387) *Fosiella lejolisii* is distinguished from *L. affinis* and *L. bermudense* by having thallus cells 6-7 μm broad rather than 9-18 μm broad or 10-12 μm broad. However, cells up to 13 μm broad were found in Sargasso Sea collections, and this suggests that the relationships of the three taxa require critical reinvestigation.

ORDER CERAMIALES

Family Ceramiaceae

Genus *Antithamnion* Naegeli, 1847

Antithamnion antillarum Boergesen 1917:226, Figs. 213-216. Taylor 1960:499. Womersley and Bailey 1970:322.

TYPE LOCALITY: St. Thomas, Virgin Islands.

TYPE: C.

DISTRIBUTION: Virgin Islands, Sargasso Sea, tropical Pacific Ocean.

SPECIMENS EXAMINED: **Sargasso Sea:** 28°N-70°W, 4.iii.1970, *Volkmann* (WJW 2426); 31°N-69°29′W, 3.iii.1970, *Volkmann* (WJW 2376).

In both cases, plants occurred epiphytically on *Sargassum natans*. One (WJW 2376) bore tetrasporangia; the other was sterile. The genus *Antithamnion* in this area needs critical reinvestigation in light of recent studies of Wollaston (1968, 1971) on southern Australian and Pacific Coast species.

Genus *Ceramium* Roth, 1797

Ceramium gracillimum (Kuetzing) Griffiths and Harvey. Dawson 1962:57, pl. 20, Figs. 2-3. Feldmann-Mazoyer in Boergesen 1952:42, Fig. 21. Nakamura 1965:136, pl. 1, 5-6, Fig. 6.

Ceramium gracillimum var. *byssoideum* (Harvey) Mazoyer 1938:323. Chapman 1963:178, Fig. 186. Feldmann-Mazoyer 1940:293, Fig. 109.

Ceramium byssoideum Harvey 1853:218. Taylor 1928: 190, pl. 27, Figs. 20, 21; 1960:528, pl. 67, Figs. 1-3.

Ceramium transversale Collins and Hervey 1917:145, pl. 5, Figs. 29-31. Boergesen 1918:243.

TYPE LOCALITY: Trieste, Italy.

TYPE: C.

DISTRIBUTION: widespread in tropical and warm temperate seas; England.

SPECIMENS EXAMINED: **Sargasso Sea:** 21°58.5′N-68°20′W, 24.iv.1970, *Moore* (WJW 2642); 26°50′N-71°48′W, 5.iii.1970, *Volkmann* (WJW 2419); 26°57′N-72°58′W, 26.iv.1970, *Woelkerling* (WJW 2652); 28°N-70°W, 4.iii.1970, *Volkmann* (WJW 2428); 31°N-70°W, 5.vii.1970, *Volkmann* (WJW 2733); 32°09′N-64°58′W, 16.v.1970, *Woelkerling* (WJW 2661, 2669); 33°58.5′N-69°56.5′W, 16.v.1970, *Woelkerling* (WJW 2591); 34°N-70°W, 13.v.1970, *Woelkerling* (WJW 2609), 6.vii.1970, *Volkmann* (WJW 2746); 35°54′N-70°30′W, 13.viii.1970, *Moore* (WJW 2903); 37°N-70°W, 12.v.1970, *Woelkerling* (WJW 2619); 37°30′N-70°W, 8.vii.1970, *Volkmann* (WJW 2705); 38°22′N-70°58′W, 12.x.1970, *Volkmann* (WJW 2890).

Ceramium gracillimum is a common epiphyte on *Sargassum fluitans*, *S. natans*, and *Sargassum* sp. as well as on

other algae attached to *Sargassum* and often occurs in considerable numbers. One collection (WJW 2619) bore tetrasporangial individuals; the remainder were sterile.

Taylor (1960, p. 528) maintains *Ceramium byssoideum* and *C. gracillimum* as distinct taxa; however, following Feldmann-Mazoyer (1940), Nakamura (1965) and others the former is referred to the conspecificity of the latter. Likewise, *C. transversale* is regarded as conspecific in accordance with Feldmann-Mazoyer (1940).

Ceramium fastigiatum Harvey in Hooker [non *C. fastigiatum* Roth = *Polysiphonia fastigiata* (Roth) Greville]. Boergesen 1918:241, Fig. 231. Chapman 1963:177, Fig. 184a-c. Nakamura 1965:129, pl. 1(3), Fig. 4. Taylor 1928:191; 1957:309, pl. 47, Figs. 3-5, 7, pl. 48, Figs. 2-4, pl. 49, Figs. 3-4, pl. 50, Fig. 4, pl. 51, Figs. 6-7; 1960:526, pl. 67, Figs. 4-6.

TYPE LOCALITY: Great Britain.

TYPE: TCD.

DISTRIBUTION: widespread.

SPECIMENS EXAMINED: **Sargasso Sea:** 28°N-70°W, 4.iii.1970, *Volkmann* (WJW 2427); 31°N-69°29′W, 3.iii.1970, *Volkmann* (WJW 2348, 2370, 2373); 34°N-70°W, 7.iii.1970, *Volkmann* (WJW 2395); 39°07′N-70°35′W, 16.viii.1970, *Moore* (WJW 2923).

This taxon occurs as an epiphyte on *Sargassum fluitans*, *S. natans*, and *Sargassum* sp. All specimens examined were sterile. The author citations of Taylor (1960) and Boergesen (1918) (i.e. *C. fastigiatium* (Roth) Harvey) are incorrect; Roth's taxon was described from Germany and has been referred by Greville (1824) to *Polysiphonia* (see DeToni, 1903, p. 945-6) whereas Harvey's taxon was described from Great Britain (Harvey in Hooker, 1833).

Genus *Crouania* J. Agardh, 1842

Crouania attenuata (C. Agardh) J. Agardh, Boergesen 1917:230, Figs. 219-221. Chapman 1963:167, Fig. 173. Collins and Hervey 1917:142. Harvey 1853:226, Tab. XXXI, D. Taylor 1928:193, pl. 27, Figs. 7-9, pl. 32, Fig. 9.

TYPE LOCALITY: Mediterranean Sea.
TYPE: LD.
DISTRIBUTION: Mediterranean, England, tropical western Atlantic Ocean, Japan.

SPECIMENS EXAMINED: **Sargasso Sea:** 37°N-70°W, 12.v.1970, *Woelkerling* (WJW 2626); 39°30′N-71°W, 6.x.1970, *Volkmann* (WJW 2882).

Male (WJW 2626) and tetrasporangial (WJW 2882) individuals occurred as epiphytes on *Sargassum natans* and on *Sargassum* sp.

Genus *Griffithsia* C. Agardh, 1817

Griffithsia radicans Kuetzing 1862:11, tab. 33, Fig. A-C. Taylor 1960:515.
TYPE LOCALITY: Brazil.
TYPE: L.
DISTRIBUTION: Brazil, Sargasso Sea.

SPECIMENS EXAMINED: **Sargasso Sea:** 37°N-70°W, 12.v.1970, *Woelkerling* (WJW 2629); 39°30′N-71°W, 6.x.1970, *Volkmann* (WJW 2881).

The plants occurred as epiphytes on *Sargassum natans* and *Sargassum* sp. and appeared to have some tetrasporangial initials. They are referred to this species because of their agreement with the description given by Taylor (1960).

Genus *Spermothamnion* Areschoug, 1847

Spermothamnion investiens (Crouan in Maze et Schramm) Vickers. Boergesen 1909:17, Fig. 10; 1917:200, Figs. 189-190; 1920:461, Fig. 422. Collins and Hervey 1917:132. Howe 1920:578. Taylor 1960:520.
TYPE LOCALITY: Guadeloupe.
TYPE: PC.
DISTRIBUTION: North Carolina, Caribbean Islands, Sargasso Sea.

SPECIMENS EXAMINED: **Sargasso Sea:** 39°30′N-71°W, 6.x.1970, *Volkmann* (WJW 2863).

Female and tetrasporangial plants were found as epiphytes on "*Sargassum* A" and may not, therefore, be a

permanent component of the Sargasso Sea flora. Tropical and subtropical western Atlantic members of the Spermothamneae are in need of thorough reinvestigation in light of the recent study of Gordon (1972).

Genus *Wrangelia* C. Agardh, 1828

Wrangelia argus (Montagne) Montage. Boergesen 1916: 116, Figs. 125-6. Gordon 1972:40. Taylor 1928:144, pl. 20, Fig. 13, pl. 22, Fig. 6, pl. 32, Fig. 4; 1960:502, pl. 66, Figs. 7-8.

TYPE LOCALITY: unknown.

TYPE: probably C.

DISTRIBUTION: see Gordon 1972, p. 40.

SPECIMENS EXAMINED: **Sargasso Sea:** 31°N-69°29′W, 3.iii.1970, *Volkmann* (WJW 2371); 37°N-70°W, 12.v.1970, *Woelkerling* (WJW 2628); 39°30′N-71°W, 6.x.1970, *Volkmann* (WJW 2880).

Male and tetrasporangial plants occurred as epiphytes on *Sargassum natans* and on *Sargassum* sp.

Family Dasyaceae

Genus *Dasya* C. Agardh, 1824

Dasya rigidula (Kuetzing) Ardissone. Howe 1920:576. Taylor 1960:558, pl. 72, Fig. 4.

TYPE LOCALITY: Spalato, Adriatic Sea.

TYPE: L.

DISTRIBUTION: Bermuda, Caribbean Islands, Mexico, Sargasso Sea, Venezuela, Adriatic and Mediterranean Seas.

SPECIMENS EXAMINED: **Sargasso Sea:** 34°N-70°W, 7.iii.1970, *Volkmann* (WJW 2398); 36°N-70°36′W, 9.xii.1970, *Moore* (WJW 2941); 39°30′N-71°W, 6.x.1970, *Volkmann* (WJW 2861, 2884).

Male, female, and tetrasporangial plants occurred epiphytically on *Sargassum fluitans* and on *Sargassum* sp.

Genus *Heterosiphonia* Montagne, 1842

Heterosiphonia wurdemanni (Bailey in Harvey) Falkenberg 1901:638, pl. 16, Fig. 11. Boergesen 1919:324, Figs. 326-328. Collins and Hervey 1917:131. Howe 1920:575. Taylor 1928:178, pl. 25, Fig. 3; 1960:565, pl. 72, Fig. 9.

Dasya wurdemanni Bailey in Harvey 1853:64, Tab. XV, C.

TYPE LOCALITY: Key West, Florida.

TYPE: TCD.

DISTRIBUTION: western tropical Atlantic; Mediterranean.

SPECIMENS EXAMINED: **Sargasso Sea:** 34°N-70°W, 10.i.1970, *Volkmann* (WJW 2213).

A single tetrasporangial plant occurred epiphytically on "*Sargassum* B"; its status in the Sargasso Sea flora must remain in doubt until further collections come to hand.

Family Delesseriaceae

Genus *Hypoglossum* Kuetzing, 1843

Hypoglossum tenuifolium (Harvey) J. Agardh. Howe 1920: 564. Taylor 1960:545, pl. 68, Fig. 2.

Delesseria tenuifolia Harvey 1853:97, Tab. XXII, Fig. B. Boergesen 1919:344, Figs. 340-343.

TYPE LOCALITY: Key West, Florida.

TYPE: TCD.

DISTRIBUTION: western tropical Atlantic Ocean.

SPECIMENS EXAMINED: **Sargasso Sea:** 34°N-70°W, 10.i.1970, *Volkmann* (WJW 2220).

A single plant was found epiphytically on "*Sargaassum* B", and until further collections come to hand, its status as a permanent component of the Sargasso Sea flora must remain in doubt.

Family Rhodomelaceae

Genus *Chondria* C. Agardh, 1817

Two collections — one tetrasporangial [37°N-70°W, 12.v.1970, *Woelkerling* (WJW 2632)] and one sterile [39°07′N-70°35′W, 16.viii.1970, *Moore* (WJW 2910)] — contained very small (less than 1 cm long) plants of *Chondria* attached to *Sargassum natans*. While both plants appear to come close to the diagnosis of *Chondria dasyphila* (Woodward) C. Agardh provided by Taylor (1960, p. 616), specific affinity could not be determined with certainty on the basis of the material at hand.

Genus *Herposiphonia* Naegeli, 1846

Herposiphonia secunda (C. Agardh) Ambronn. Boergesen 1920:469, Figs. 428-429. Chapman 1963:125, Figs. 130 a-b. Collins and Hervey 1917:126. Howe 1920:574. Taylor 1928:176, pl. 25, Figs. 8-10; 1960:604, pl. 72, Figs. 10-11.

TYPE LOCALITY: LD.

TYPE: LD.

DISTRIBUTION: western tropical Atlantic Ocean, Mediterranean Sea, Adriatic Sea.

SPECIMENS EXAMINED: **Sargasso Sea:** 31°N-69°20′W, 3.iii.1970, *Volkmann* (WJW 2362); 32°09′N-64°58′W, 16.v.1970, *Woelkerling* (WJW 2660); 36°N-70°36′W, 9.xii.1970, *Moore* (WJW 2935); 37°N-70°W, 12.v.1970, *Woelkerling* (WJW 2630); 39°07′N-70°35′W, 16.viii.1970, *Moore* (WJW 2911); 39°30′N-71°W, 6.x.1970, *Volkmann* (WJW 2864).

Male, female and tetrasporangial plants have been found on *Sargassum fluitans, S. natans,* and on *Sargassum* sp.

Herposiphonia tenella (C. Agardh) Naegeli. Boergesen 1918:286, Figs. 287-289; 1920:472, Fig. 430. Chapman 1963:127, Fig. 133. Collins and Hervey 1917:126. Howe 1920:573. Taylor 1928:177, pl. 25, Fig. 11; 1960:604, pl. 72, Fig. 12.

TYPE LOCALITY: Sicily.

TYPE: LD.

DISTRIBUTION: western tropical Atlantic Ocean; Mediterranean and Adriatic Seas.

SPECIMENS EXAMINED: **Sargasso Sea:** 33°58.5′N-69°56.5′W, 15.v.1970, *Woelkerling* (WJW 2596); 39°30′N-71°W, 6.x.1970, *Volkmann* (WJW 2875).

The tetrasporangial specimens (WJW 2875) grew epiphytically on *Sargassum hystrix;* the sterile material was found on "*Sargassum* C." Until specimens attached to *S. fluitans* and/or *S. natans* are collected the status of this taxon as a permanent component of the Sargasso Sea remains in doubt.

Genus *Laurencia* Lamouroux, 1813

Tropical Atlantic American species of *Laurencia* are in need of critical study in light of the recent investigations of Saito (1967, 1969). Saito (1967, p. 72-73) recognizes 5 subgenera of *Laurencia* based on the presence or absence of secondary pit connections in the cortex, shape of cortical cells, presence or absence of lenticular thickenings in medullary cell walls, and plant form (compressed or cylindrical). Taylor (1960) does not provide full information on these features, and his keys are based partly on features of questionable taxonomic significance, thus making specific identification of taxa difficult.

Seven collections of *Laurencia* have been made during the present study, but in view of their small size (mostly under 1 cm tall) and with one exception their sterile condition, species affinities have not been determined. One of these [34°N-70°W, 30.vi.1970, *Volkmann* (WJW 2729)] belongs to the subgenus *Palisadae;* the other six [31°N-69°29′W, 3.iii.1970, *Volkmann* (WJW 2361); 33°58.5′N-69°56.5′W, 15.v.1970, *Woelkerling* (WJW 2593); 34°N-70°W, 6.vii.1970. *Volkmann* (WJW 2745); 37°N-70°W, 12.v.1970, *Woelkerling* (WJW 2636); 37°30′N-70°W, 8.vii.1970, *Volkmann* (WJW 2710); 39°30′N-71°W, 6.x.1970, *Volkmann* (WJW 2874)] belong to the subgenus *Chondrophycus*. The specimens occurred as epiphytes on *Sargassum natans* and on *Sargassum* sp.

Genus *Lophosiphonia* Falkenberg, 1897

Lophosiphonia cristata Falkenberg 1901:499, Tab. 9, Figs. 7-10. Boergesen 1918:297, Figs. 295-298. Chapman 1964:125, Fig. 129. Hollenberg 1958:68. Taylor 1960: 606.

TYPE LOCALITY: Scogliera, Puntadel Posilipo, Gulf of Napal.

TYPE: not located.

DISTRIBUTION: Mediterranean, Bermuda, Bahamas, Jamaica, Virgin Islands, Sargasso Sea.

SPECIMEN EXAMINED: **Sargasso Sea:** 31°N, 69°29′W, 3.iii.1970, *Volkmann* (WJW 2363).

The single collection contained tetrasporangial plants epiphytic on *Sargassum fluitans*.

Genus *Polysiphonia* Greville, 1824

As noted by Taylor (1960, p. 572-3), much taxonomic uncertainty exists over tropical American Atlantic species of *Polysiphonia*, and a critical revision of the genus for this region is badly needed. Although several sources (including Taylor, 1960) have been consulted during this study, taxonomic identifications of Sargasso Sea collections have been made mainly from the publications of Hollenberg (1968, 1968a). The relationships of Hollenberg's Pacific taxa to the species names employed by Taylor (1960) for tropical American Atlantic taxa remain uncertain.

Polysiphonia delicatula Hollenberg 1968:62, Fig. IF.

TYPE LOCALITY: Pokai Bay, Oahu, Hawaii.

TYPE: US (D1911662).

DISTRIBUTION: Hawaiian Islands, Tuamotu Archipelago, Marshall Islands, Caroline Islands, Sargasso Sea.

SPECIMENS EXAMINED: **Sargasso Sea:** 28°N-70°W, 4.iii.1970, *Volkmann* (WJW 2423); 33°58′N-69°56.5′W, 15.v.1970, *Woelkerling* (WJW 2595); 37°N-70°W, 12.v.1970, *Woelkerling* (WJW 2631, 3229).

Female and tetrasporangial plants occurred as epiphytes on *Sargassum natans* and *Sargassum* sp.

Polysiphonia lanosa (L.) Tandy. Taylor 1957:341, pl. 56, Fig. 4, pl. 57, Figs. 14-15, pl. 59, Fig. 4. Woelkerling 1972:298.

Polysiphonia fastigiata auct. non. (Roth) Greville: Collins, Holden, and Setchell 1895:145; 1907:1444. Farlow 1881: 175. Harvey 1853:54.

TYPE LOCALITY: unknown.

TYPE: LINN.

DISTRIBUTION: North Atlantic Ocean.

SPECIMENS EXAMINED: **Sargasso Sea:** 38°53′N-69°39′W, 10.v.1970, *Woelkerling* (WJW 2565).

Polysiphonia lanosa occurred as an epiphyte on *Ascophyllum nodosum* (see Woelkerling, 1972) and is regarded as an invader.

Polysiphonia poko Hollenberg 1968:70, Figs. 3A, 15, 22.

TYPE LOCALITY: North Island, Pacific Ocean.

TYPE: US (H65-113.1).

DISTRIBUTION: tropical Pacific Islands (see Hollenberg), Sargasso Sea.

SPECIMENS EXAMINED: **Sargasso Sea:** 34°N-70°W, 10.i.1970, *Volkmann* (WJW 2207); 37°30′N-70°W, 8.vii.1970, *Volkmann* (WJW 2703); 39°30′N-71°W, 6.x.1970, *Volkmann* (WJW 2858).

Female and tetrasporangial plants occurred as epiphytes on *Sargassum natans* and *Sargassum* sp.

SUMMARY

The epibiotic and pelagic algal flora of the western Sargasso Sea has been extended to include ten Chlorophyceae, 25 Phaeophyceae, and 33 Rhodophyceae. Nearly 75% of these taxa are newly reported for the Sargasso Sea. Pertinent references and taxonomic and ecological data are provided for each taxon, and indication is provided as to whether each species is likely to be a permanent component of the Sargasso Sea flora or merely a temporary invading element.

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SAXIFRAGES ON MOUNT WASHINGTON

In Rhodora 69: 483-486, three brief articles were published regarding the rediscovery of *Saxifraga Aizoon* Jacq. and *Saxifraga cernua* L. in Huntington Ravine on Mt. Washington. These plants were first discovered by Dr. John Churchill in 1939 but were apparently not seen again until 1967 when Steele, Hodgdon and James Teeri relocated them. Although it was not possible to reach the plants because of the steepness of the cliff, observations were made through field glasses. *Saxifraga Aizoon* was growing in some abundance on a nearly flat ledge about twenty feet above a vantage point which was reached without too much difficulty. The plants in full bloom with conspicuous typical lime encrusted leaves, were unmistakable even when viewed at a distance of 100 feet from the bottom of the cliff. On a steep shelf at a distance of forty feet from the vantage point, Hodgdon detected a single flower which he believed to be *Saxifraga cernua*, a plant he had become familiar with on an Alaskan expedition. Steele, although not familiar with the plant was skeptical and unwilling to accept the identification. The plant was completely inaccessible so there seemed to be no way to resolve the question without the aid of rockclimbers.

Upon learning of the dilemma, Countryman undertook to secure the aid of members of Norwich University's Mountain Rescue Team. Accordingly, another expedition was organized in 1970 consisting of Countryman, Hodgdon, Steele and three technical rock climbers from Norwich. The vantage point below the *Saxifraga Aizoon* shelf was easily reached but it was then discovered that nearly all the soil and vegetation was gone from the ledge, presumably having been removed by avalanche or flood, a matter which emphasized the extreme ecological instability of the whole area. The date of this expedition, Aug. 2, was past the flowering time of the saxifrages and at first none were in evidence. Soon Hodgdon, with the aid of field glasses,

was able to locate some plants of *S. Aizoon* on a ledge above the original shelf. Ray Quirk, a rock climbing instructor at Norwich, undertook to investigate, assisted by John P. Quirk and Jon W. Walsh, both undergraduates at that institution. The ledge was very steep and the rocks unstable, but with the use of direct aid in the form of pitons and a sling and tension from below, Quirk was eventually able to reach the site. Guided by instructions from below he was able to obtain small but unmistakable portions of both saxifrages, these being the first collections from Mt. Washington since 1939. It would have been desirable to investigate another ledge but the lateness of the hour prevented this.

After this trip, in discussing the 1967 expedition, a friendly dispute broke out between Steele and Hodgdon as to the exact location of the *Saxifraga cernua* observed at the time. To settle this point, and because one promising shelf still had not been investigated, another expedition was organized by Steele in 1971, with a date selected for what was believed to be the height of the flowering season of both plants. Two rock climbers accompanied the expedition. From the vantage point eighty feet up the cliff, *S. cernua* was readily observed in flower on a vegetation covered shelf below the original *S. Aizoon* ledge. With the aid of a rope and a good belay from Paul Henle, Nathaniel Steele was able to reach the slope. He made some careful observations and collected one fragment of a plant plus some leaves. There were seven plants of *S. cernua* in bloom plus some patches of leaves. The slope was steep and unstable with many loose rocks. It would not be difficult for all the vegetation to be dislodged in a slide.

Steele (senior) searched the whole area carefully with field glasses and eventually located a small clump of *S. cernua* leaves in a small pocket near the original *S. Aizoon* ledge. On the higher ledge explored in 1970, a considerable amount of *S. Aizoon* was observed in full bloom. The onset of a thunderstorm prevented any further exploration, but presumably *S. cernua* was there also.

The narrow gully continues very steeply above this site nearly to the head of the ravine, but overhanging rock makes it impossible to see into it from the bottom; thus it is possible there are colonies of saxifrage farther up, seeds from which might occasionally wash down and colonize suitable areas. It would appear this possibility could be confirmed only by a team of strong rock climbers.

For any who might be inclined to investigate this or other rare alpine plants, the authors suggest the following as a result of their experiences. High powered field glasses are very useful. Careful notes should be taken at the time as to what is observed. Drawings and photographs of the locality would be most helpful. A camera equipped with a telephoto lens would make an excellent record of the plant. All information thus obtained could be put on an herbarium sheet.

It may seem strange that Dr. Churchill was able to discover new plants in an area that had long been heavily botanized. He was fortunate in that he was doing his explorations during the short flowering season. His very conscientious exploration and mountaineering ability no doubt led him to the vantage point eighty feet from the bottom from which he could observe the plants without field glasses. How he was able to manage the last twenty feet without a rope and a belay from a second remain a mystery to the various technical rock climbers who have visited the area. The area is ecologically unstable and there is a slight possibility that he collected his plants from a station lower down that is now extinct. Because of the instability the authors feel that further exploration is inadvisable in that it might lead to destruction of the very limited habitat.

Records for the plants now exist in the herbaria of the University of Michigan, the New England Botanical Club, the University of New Hampshire, Norwich University and the Steele private herbarium in Tamworth, New Hampshire.

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RUDBECKIA AURICULATA (PERDUE) KRAL, A SPECIES DISTINCT FROM R. FULGIDA AIT.

ROBERT KRAL

During field work toward a flora of Alabama I have come across several additional populations of a very tall, smoothish, rhizomatous *Rudbeckia,* which was originally described by Perdue (1961) from a single population in Covington County as var. *auriculata* of *R. fulgida* Ait. Admittedly, *R. fulgida* is extremely variable, presenting a broad spectrum of radiate extremes (Perdue treats seven in his 1957 treatment of the complex) over a broad range of habitats and geography. However, this particular *Rudbeckia* varies from the other "fulgidas" so much, and so consistently, that to treat it as another variety of *R. fulgida* would be inconsistent with species concepts in *Rudbeckia.* Perhaps I can best demonstrate this situation by offering descriptions of *R. fulgida* and *R. auriculata* (*R. fulgida* var. *auriculata* Perdue), these based on 45 samples of the former and ten of the latter. The description of *R. fulgida* is broadened to include the three varieties now known to occur within Alabama and Tennessee, which are possibly sympatric with *R. auriculata.*

R. fulgida Ait. var. *fulgida.* Plate 1(2) ; Plate 2(3).

R. fulgida Ait., Hort. Kew. 3: 251. 1789.
R. chrysomela Michx. Fl. Bor. Am. 2: 143. 1803.
R. truncata Small, Bull. Torr. Bot. Club 25: 478. 1898.
R. acuminata Boynt. & Beadle, Fl. S.E.U.S. ed. 1. 1256. 1903.
R. foliosa Boynt. & Beadle, Fl. S.E.U.S. ed. 1. 1256. 1903.
R. tenax Boynt. & Beadle, Fl. S.E.U.S. ed. 1. 1257. 1903.

Stoloniferous-rhizomatous perennials to 1.3 m. tall, perennating by one or more slender, stoloniferous offshoots, these later thickening and becoming rhizomatous. Rosette leaves

PLATE 1

PLATE 1. Pales, akenes and corollas of *Rudbeckia*.

1. *Rudbeckia auriculata*. 1a. akene; 1b. disc corolla; 1c. pale, outer surface. Drawn from *Kral 48579*.
2. *Rudbeckia fulgida* var. *fulgida*. 2a. pale, outer surface; 2b. akene and disc corolla. Drawn from *Kral 33107*.
3. *Rudbeckia fulgida* var. *umbrosa*. 3a. akene and disc corolla; 3b. pale, outer suface. Drawn from *Kral 32945*.

with blades ovate to lanceolate or elliptic, altogether 3-11 (-25) cm. long, on petioles shorter than to as long as the blades, the margins ranging from entire to undulate, crenate, dentate, or serrate, the bases cuneate to attenuate, the surfaces glabrous to (usually) appressed-strigose. Stems erect, proximally hirsute or strigose or smooth, distally strigose, strigillose or smooth, and terete or sulcate-costate. Heads few to many, long pedunculate usually from the axils of upper stem leaves and forming an open "candelabra-like" cyme. Lower stem leaves similar in outline and indumentum to rosette leaves, grading upward to shorter, narrower, sessile or even clasping. Phyllaries oblong, slightly to much shorter than the rays, green, ciliolate-scabrid, reflexed. Rays short-oblong to elliptic, 0.9-1.7 cm. long, spreading or slightly recurved, often strigillose on the backs, orange-yellow (frequently drying greenish). Disc 1.0-1.8 cm. broad, the pales oblanceolate or cuneate, rarely elliptical, 4-5 mm. long, short-acuminate to acute or obtuse, the margins entire to sparsely ciliolate, the outer surfaces distally a deep reddish-brown becoming proximally tan with the 3 nerves, particularly the 2 submarginal laterals a deep lustrous reddish-brown, smooth or sparsely strigillose especially toward the tips. Disc corollas 3.0-3.5 mm. long, the tube shorter than the narrowly campanulate or broadly tubular throat, the lobes short-triangular and erect, the whole corolla deep purple-brown. Akenes asymmetrically short-oblong, 2.0-2.5 mm. long, curvate proximally, usually 4-angled, dark gray, the pappus a low, slightly uneven crown less than 0.5 mm. long or almost obsolete.

This entity inhabits prairies, swales, open woods, fields, and roadsides, on a variety of soils and in dry to quite wet situations from New Jersey to Illinois, south to Florida and Louisiana. It is definitely the most widespread, certainly

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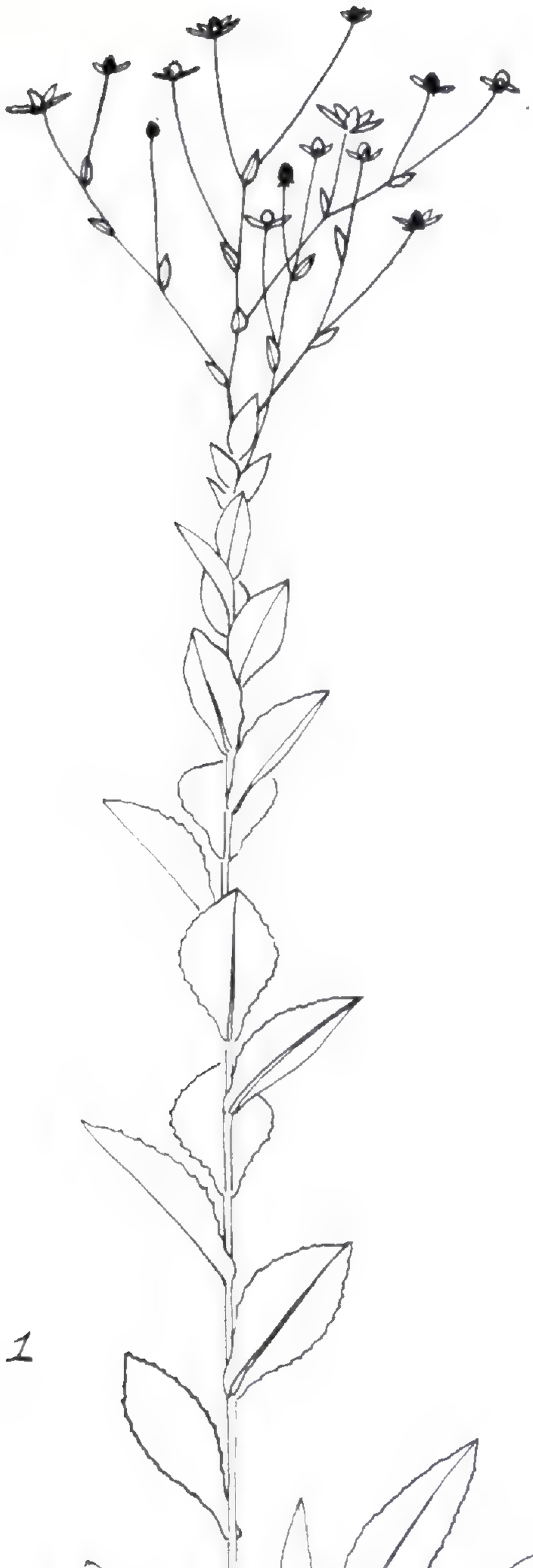
PLATE 2. Habit sketches of *Rudbeckia*.
1. *Rudbeckia auriculata*.
2. *Rudbeckia fulgida* var. *umbrosa*.
3. *Rudbeckia fulgida* var. *fulgida*.



1

2

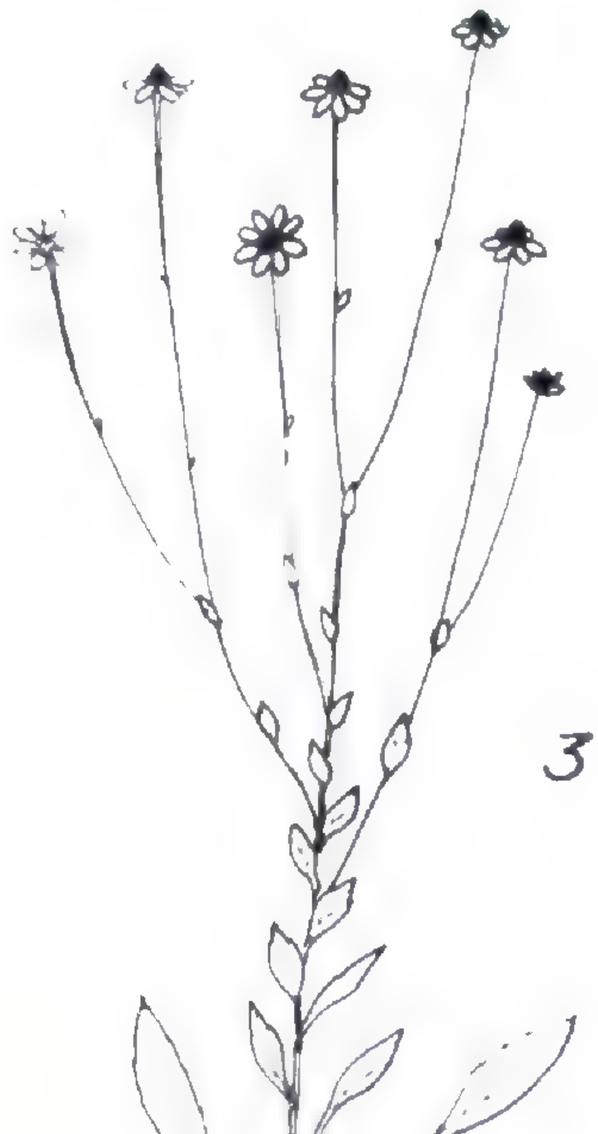


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PLATE 2

the most variable taxon of the complex. It and the other varieties of *R. fulgida* all display a fine orange-yellow ligule color that distinguishes them well from other Rudbeckias in the late summer and early autumn fields.

R. fulgia Ait. var. *umbrosa* (Boynt. & Beadle) Cronq., Rhodora 47: 400. 1945. Plate 1(3); Plate 2(2).
R. umbrosa Boynt. & Beadle, Biltmore Bot. Stud. 1: 16. 1901.
R. chapmanii Boynt. & Beadle, Biltmore Bot. Stud. 1: 14. 1901.

Differs from var. *fulgida* in being stouter, the stem often angular, usually smoother, taller (frequently 1 m. tall), with stouter rhizomes. Rosette and lower stem leaves proportionately large, long-petiolate with ovate or lance-ovate, cordate-based blades, these either glabrous or strigose or scabrid, and with entire to crenate-dentate margins. Heads larger, the rays longer, usually elliptic-oblong, and often fully 3 cm. long, the disc often to 2 cm. broad. Pales consistently ciliate distally save for most inner ones. Akenes similar in shape but usually longer, to 3 mm.

This variety is perhaps the showiest of the Alabama-Tennessee fulgidas, in my opinion an excellent horticultural subject because of its late and long-blooming habit and its full inflorescence. Its best habitats are sunny, moist to quite wet swales and seeps from Virginia west to Ohio and south to Alabama and Georgia.

R. fulgida Ait. var. *spathulata* (Michx.) Perdue, Rhodora 59: 297-298. 1957.
R. spathulata Michx. Fl. Bor. Am. 2: 144. 1803.

Most similar to var. *fulgida*, with rosette and basal stem leaves attenuated to the petiole, not cordate. Stems ranging from glabrous to variously hirsute or strigose; mid- and upper stem leaves ranging from broadly spatulate to oblanceolate or pandurate, and from glabrous to strigose. Heads as small as in var. *fulgida* with rays short (rarely as long as 2 cm.).

This variety grows in low, moist to wet, sunny places or in low open woods from Virginia west to Tennessee and south to Florida and Alabama. In habit, rosette and stem leaves, inflorescence, and head it is so similar to extremes of *R. fulgida* var. *fulgida* as to be indistinguishable, and its status as a variety to me appears hardly tenable.

R. auriculata (Perdue) Kral, stat. nov. Plate 1(1); Plate 2(1).

R. fulgida Ait. var. *auriculata* Perdue, Rhodora **63**: 119-120. 1961.

Robust, rhizomatous, glabrous or subglabrous perennial to 3 m. tall, perennating by short, stoloniferous offshoots, these becoming stout (to 1 cm. or more thick) by the second season. Rosette and lower stem leaves to 65 cm. long, the blades oblong to oblanceolate or ovate-lanceolate, short-acuminate to rounded or acute, entire to sinuate, crenate, dentate, coarsely serrate or denticulate, on petioles from 1/3-1/2 the total leaf length, the surfaces smooth to scabrous and usually strigose on the veins, midrib and petiole. Stems erect, stiffish, proximally fully 1 cm. thick, subterete, multicostate to sulcate. Middle and upper cauline leaves sessile, the blades progressively reduced up the stem, elliptical to ovate or pandurate, acute, the margins entire to dentate, denticulate or coarsely serrate, the bases auriculate-clasping, the surfaces from smooth to sparsely scabrid or strumose. Heads many in an open, broadly convex, paniculate cyme. Phyllaries oblong-linear, spreading, shorter than rays, smooth save for scaberulous margins. Pales oblong-cuneate, ca. 6 mm. long, acute, ciliate, the backs hirsutulous, proximally tan with maroon mid- and sub-marginal nerves, distally a deep reddish-brown. Rays bright yellow, oblong-linear, ca. 2 cm. long, spreading or spreading-ascending, the backs frequently strigillose. Disc 1.0-1.7 cm. broad, the corollas purple-brown, 3.0-3.5 mm. long, the short tube gradually expanding into the narrowly funnelform throat, the lobes short-triangular, erect. Akenes oblong-curvate, 4.0-4.5 mm. long, a rich, lustrous reddish-

brown, 4 ribbed, the pappus prominently unevenly 4-6-toothed, the teeth pale tan, chartaceous, narrowly triangular, the longer ones fully 2 mm. long.

TYPE: **Alabama:** COVINGTON CO.: moist soil along Alabama Highway 55, 11 mi. south of McKenzie (2 mi. n. of Red Level), 24 July 1958, *R. E. Perdue* 2177. Holotype at GH, Isotype at US.

Rudbeckia auriculata inhabits bogs, swamps, seeps, ditches and swales, mostly in full sun, sometimes in partial shade at edges of swamp woodlands. So far, most of the samples are from the lower Coastal Plain in Alabama, but I have found one outlier in the Appalachians, northeast of Birmingham in St. Clair County in the broad limestone valley between Oak Mountain and Blount Mountain. Oddly enough, one of its neighbors there is *Leavenworthia exigua* var. *lutea,* which appears in patches in spring on low outcrops of calcareous rock. Because Alabama is even now rather poorly studied for its flora, other populations connecting the montane ones with the Coastal Plain ones will probably be discovered. The plants are so tall (some reaching 3 m. in height!) as to be conspicuous even at a distance, the only other *Rudbeckia* of comparable height in the area being *R. laciniata.*

Rudbeckia auriculata, to summarize, differs from *R. fulgida* in the following ways:

1. The plants are usually at least twice as tall, arising from much stouter rhizomes, and are prevalently smooth-stemmed.
2. The foliage is, overall, larger, with cauline leaves prevalently panduriform, auriculate-clasping; this character is stressed by Perdue (l.c.) in his varietal distinction. The phyllaries are hairy on the backs with spreading or ascending hairs.
3. The rays are a bright yellow, not an orange-yellow as in the fulgidas of the southeastern U.S. It is to be suspected that their pigment chemistry is quite different.

4. The disc corollas are shorter than the akenes. In *Rudbeckia fulgida* the reverse is true, *i.e.*, the akenes are shorter than the disc corollas.

5. The akenes are narrower in outline and longer than are those of *Rudbeckia fulgida*, and are a lustrous red-brown rather than gray-tinted.

6. The pappus is prominent, produced upward into narrowly triangular scales, these longer than is true for any other southeastern *Rudbeckia*. In *R. fulgida* the pappus is usually a low, uneven crown or is nearly absent.

Thus, when one considers the many striking character differences, this is not only a species distinct from *Rudbeckia fulgida*, but indeed might well comprise a part of another section of the genus. Only a revisional attempt would disclose this fact, but the taxa nearest to *R. auriculata* in pappus character and in some respects of head characteristics are, in southeastern U.S., *R. nitida* and *R. mohrii*.

A cytological comparison of some southeastern Rudbeckias is to be initiated during the summer of 1974, for there is sufficient phenotypic difference to assume a considerable chromosomal difference, at least from *R. fulgida* and its varieties.

The following are some recently collected localities for populations of *Rudbeckia auriculata:*

Alabama: BARBOUR CO.: swampy ditch beside low oak forest, Lugo, 12 Sept. 1968, *R. Kral* with *K. E. Blum* 33300. COVINGTON CO.: tall plants of peaty swale by Ala. 55, just n. of Red Level, 30 Aug. 1970, *Kral* 40841; sandy silt of creek bottoms by Ala. 54, 7.8 mi. n.e. Florala, plants to 8′ tall, 24 Jul. 1968, *Kral* 31970. CRENSHAW CO.: n. side Luvergne, sandy creek bottom by U.S. 231, plants to 3 m., 16 Aug. 1968, *Kral* 32421. GENEVA CO.: sandy peat of longleaf pineland ditch due e. of Samson, just outside limits by Ala. 52, 3 Sept. 1969, *Kral* 36837; 5 mi. s. of Samson along Ala. 187, moist ditch, grown up waste area, roadsides, 18 Aug. 1970, *H. D. Moore* 640. PIKE CO.: sandy shores of Pike Co. public lake, s. of Troy, 11 Sept. 1968, *Kral* 33174. ST. CLAIR CO.: ca. 4 mi. n. Leeds, abundant clone in wet cleared area of pasture, 27 Sept. 1972, *Kral* 48579.

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APPARENT ECOTYPIC DIFFERENCES IN THE WATER RELATIONS OF SOME NORTHERN BOG ERICACEAE[1]

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The apparent paradox of xeromorphy in northern bog plants has become a popular subject again, this time however, with a new interpretation. The development of sclerophyllous leaf tissue (increased cutinization and lignification, increased fiber/protein ratio) in plants of both wet and dry habitats has recently been linked with phosphorous deficient soils (Beadle, 1966; Loveless, 1962), a feature that both deserts and northern bogs have in common. In the light of this discovery, leaf sclerophylly and the evergreen habit often associated with it are now being interpreted as reflecting a specialized metabolism tolerant of low nutrient levels, though the physiology of this adaptation is not yet fully understood (Small, 1972a, 1972b; Beadle, 1968, 1966; Monk, 1966; Loveless, 1962).

From a morphological viewpoint much of the northern bog flora seems particularly well adapted for the conservation of water. Narrow, leathery, and heavily cutinized leaves with revolute margins and vertical orientation, characters typical of many Ericaceae, are perfect water conserving adaptations. Yet these features cannot be explained on the basis of plant-water relations in the northern sphagnum bog. Early hypotheses relating these xeromorphic characters to a condition of "physiological drought," for reasons mostly associated with the anaerobic bog substrate, were dismissed long ago by Caughey (1945) for lack of experimental confirmation. More recent *in situ* determinations of the water status of bog plants by Small (1972a) and

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Marchand (1972) have likewise failed to turn up any evidence of water stress in the bog environment. While normal midday xylem water potentials in several species have been found to be quite low (−15 to −20 bars), stomatal response appears to be unaffected in this range (Small, 1972a; Marchand, 1972). Assuming that stomatal functioning is an adequate measure of plant sensitivity to its environment, there seems enough justification indeed to abandon our ideas of water stress in bogs.

This is not to suggest, however, that the subject of water relations of bog plants is closed. To the contrary, the acid and waterlogged substrate of the sphagnum bog poses some unique ecological problems, and the data of Small (1972a), as well as that of Marchand (1972), invite further investigation into possible differences in the water metabolism of bog plants and their counterparts on well drained sites. Specifically, the following questions may be asked: Why are xylem potentials of small bog shrubs so low, sometimes exceeding −20 bars, when soil water supply in this habitat is seemingly unlimited? In an environment where soil-water supply is more restricted, how low a water potential might these species tolerate, before stomatal closure is induced? Do the observed water potentials represent an optimum "operational" level for the species in question or is the level induced by some edaphic characteristic of the habitat? Presented here are some field observations which suggest possible answers to these questions.

METHODS

The Lee Hill Bog in Lee, New Hampshire, is typical of northern sphagnum peat bogs, supporting a flora dominated by several members of the family Ericaceae along with *Picea mariana* (Mill.) BSP. and *Eriophorum virginicum* L. Because the bog is situated in a kettle amidst glacial deposits, however, the surrounding upland area contrasts abruptly in both edaphic character and floristic composition. Around the perimeter of the bog, the well-drained till sup-

ports a "mesic" pine-oak community. Both the bog and adjacent upland sites, however, support well established populations of *Vaccinium corymbosum* L. and *Gaylussacia baccata* (Wang.) K. Koch, thus affording an opportunity to study simultaneously the water relations of these species under similar atmospheric conditions but under markedly different edaphic conditions. In Wolcott, Vermont, a somewhat similar situation exists in which the water status of *Ledum groenlandicum* Oeder and *Kalmia angustifolia* L. growing in a wet peat substrate was compared with that of the same species growing in a well-drained upland field.

At each site, xylem potentials were measured using a portable pressure bomb (PMS Instruments Co.) as described by Waring and Cleary (1967). The pressure bomb is designed to measure the amount of tension in the xylem water column resulting from transpirational "pull" against flow resistances in the soil-plant continuum. This xylem tension is related to the free energy of the water in the plant, the water potential. When the stem of a transpiring plant is cut, the cohesion of the water column is broken and the tension is relaxed. The water column then quickly recedes from the cut surface. By placing the branchlet into a sealed chamber with only the cut end protruding, and applying pressure, the water column can be forced back to the cut surface, thus re-establishing the initial condition. The amount of pressure required to do this is equal in absolute value to the initial xylem tension or water potential of the plant.

In this study, exposed branchlets about 10 cm. in length and bearing several leaves were used for the water potential determinations. The sample number ranged from just three stems per species when variation was low, as during the early morning hours, to six when the variation within species was higher. At the time of sampling, soil-water potentials were determined using a tensiometer (Soilmoisture Equipment Corp. No. 2900) and wet- and dry-bulb temperatures were recorded with a sling psychrometer.

Since pressure bomb measurements by themselves are difficult to interpret, stomatal response to the observed water potentials was measured with a diffusion porometer. This instrument is essentially an electric hygrometer whose resistance varies inversely with humidity. In use, a small plexiglass chamber containing a hygroscopic element is clamped onto a leaf and, in effect, the leaf is allowed to transpire under prescribed conditions. As water vapor diffuses into the initially dry chamber, the time rate of humidity increase over a narrow range is noted. From this, the diffusion resistance of the leaf, mostly a function of stomatal aperture, is calculated based on a calibration curve for known resistances.

The porometer used in this study was modified from the design of Kanemasu *et al.* (1969). In order to increase instrument sensitivity for use on very small leaves the chamber volume was reduced slightly, a higher sensitivity element (Hygrodynamics No. 4-4816K) was used, and the cup aperture was reduced to 6.35 mm. diameter. With these modifications, the time required for attachment and measurement on the leaf was usually of the order of 5 to 15 seconds when the stomates were fully open. In calibration, storage, and field use, the recommendations of Morrow and Slatyer (1971a, 1971b) were followed closely.

RESULTS

The data from the different sites are compared by using the model of Elfving *et al.* (1972) where transpiration is described by the ratio of vapor pressure deficit (VPD) to stomatal diffusion resistance (r_s). A plot of xylem water potential against VPD/r_s for the species studied here indicates that for any given transpiration rate, under non-stress conditions, xylem potentials are lower (more negative) in the bog plants than in their upland counterparts (Fig. 1).

The rapid development of a very steep water potential gradient in the bog plants was observed early in the day. At the Lee Hill Bog, where soil water potential was zero bars,

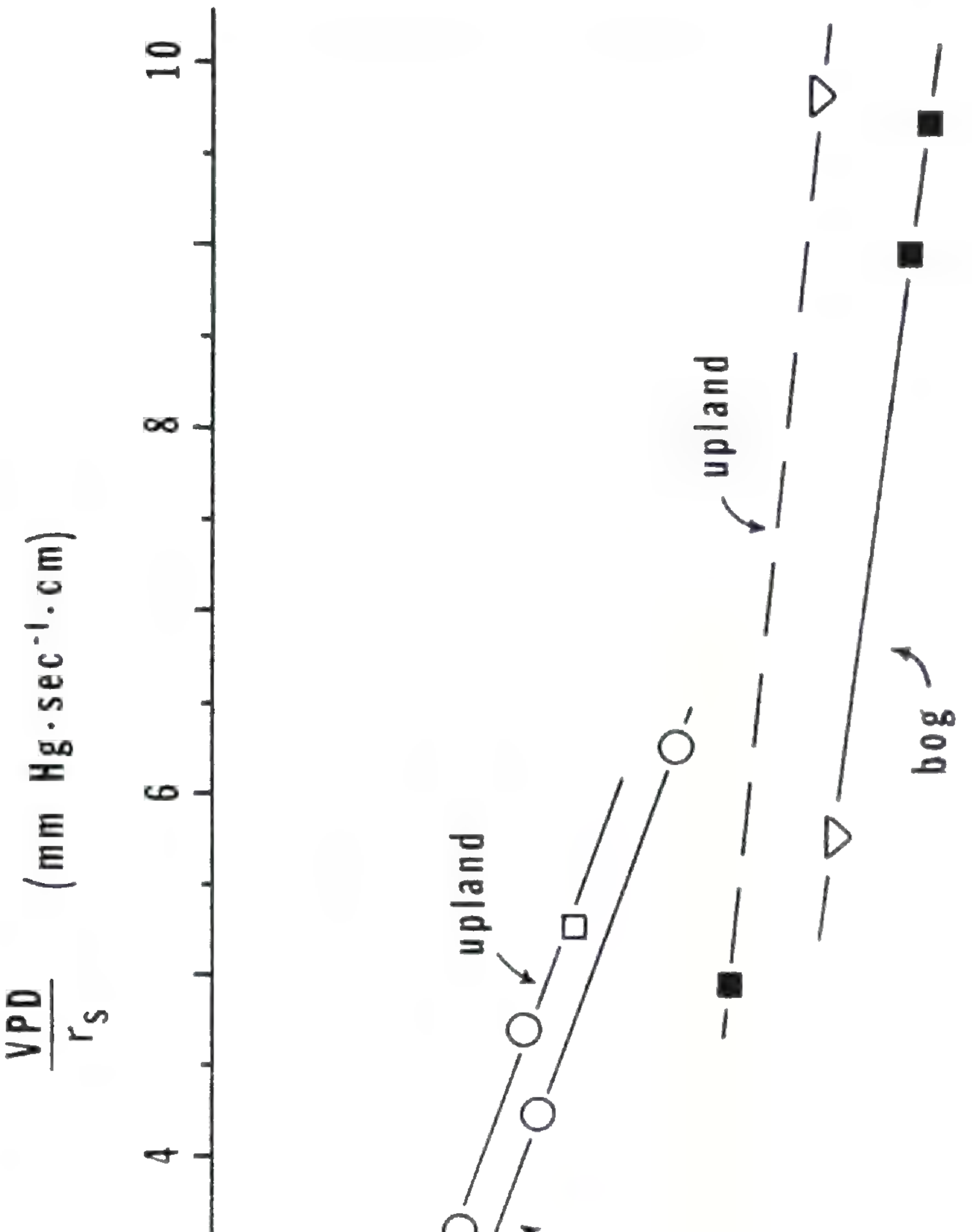

Figure 1. Xylem water potential (ψ_X) as a function of estimated transpiration rate (VPD/r_S) for bog and upland ecotypes under non-stress conditions. Symbols: ○ *L. groenlandicum;* □ *K. angustifolia;* ■ *G. baccata;* ▽ corymbosum.

transpiration from *Gaylussacia baccata* was inhibited during the first hours after sunrise by a heavy dew formation on the leaves. As soon as the dew evaporated and transpiration began, a very steep gradient was established with xylem water potential decreasing from −1 to −15 bars within one hour and further decreasing to −22 bars in the next four hours (Fig. 2). The leaf stomates remained open ($r_s = 1.1$ sec./cm.) throughout the day however. In the drier upland habitat where soil water potential was −0.3 bars, transpiration from *G. baccata* began at sunrise with xylem water potentials decreasing gradually, eventually to be checked by an increase in stomatal resistance to an average of 4.8 sec./cm. by mid-morning and 8.3 sec./cm. by mid-afternoon (Fig. 2).

While a soil-water potential of −0.3 bars is not usually considered very dry, the difference in soil-water availability between the above two sites is best indicated by the slow rate of recovery or increase of xylem potential in the upland population as compared to that of the bog population, beginning with the approach of sunset and continuing to daybreak (Fig. 2). In spite of such differences in soil-water availability, stomatal behavior, and transpiration rate (an increase in r_s from 1.1 sec./cm. to 8.3 sec./cm. is enough to cause a five-fold decrease in the transpiration rate), the mid-day depression of water potential in both populations was similar: -19.4 ± 2.8 bars in the upland population and -22.0 ± 2.7 bars in the bog population (Fig. 2).

DISCUSSION

When the rate of movement of water through the plant falls behind the rate of transpiration loss at the leaf surfaces, due either to internal resistances to flow or an insufficient soil-water supply, the result is a decrease in plant water potential. If there were no internal resistances in the plant, then in any situation where soil-water is non-limiting, the plant water potential would always be very high (near zero). Conversely, where soil-water is freely

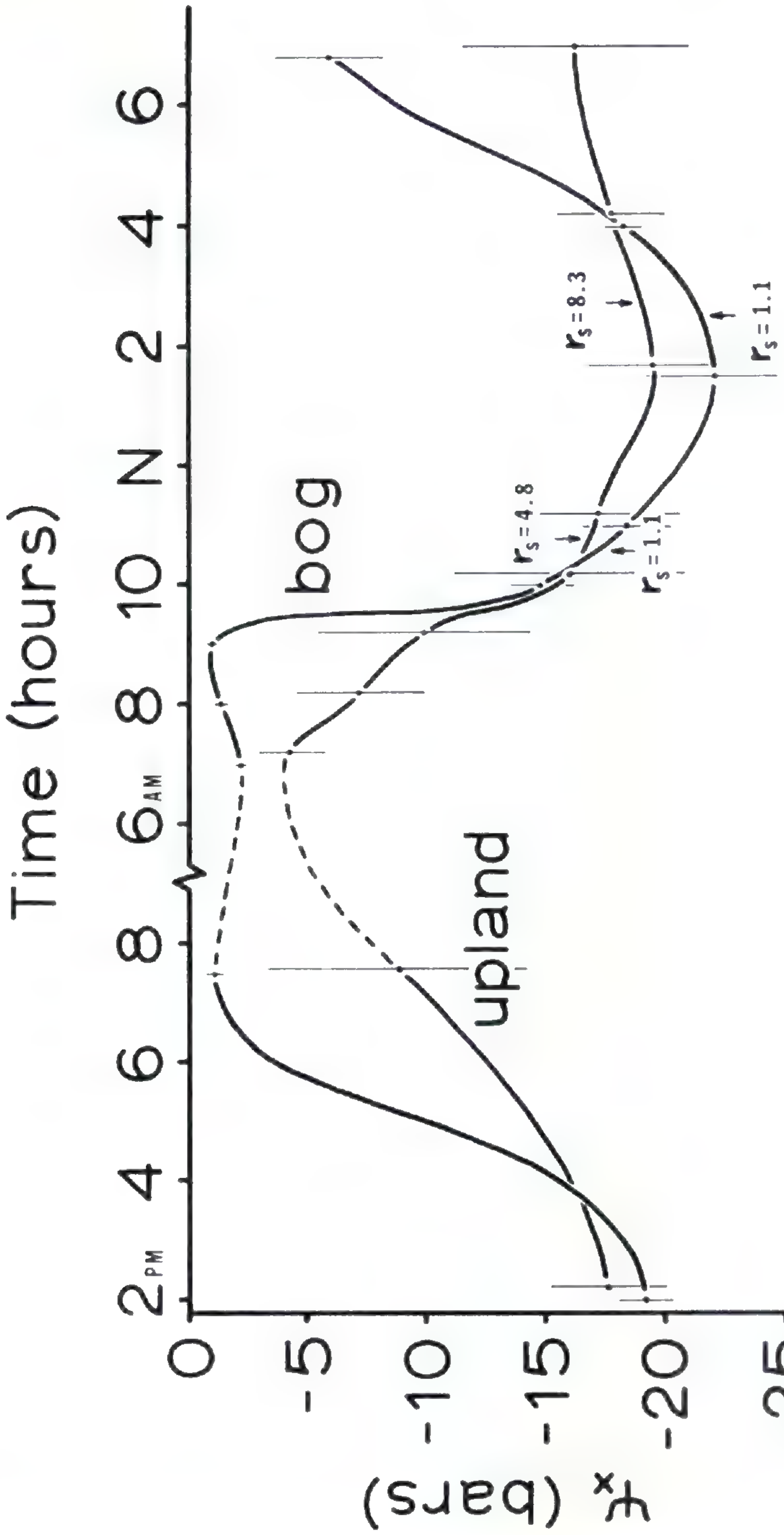

Figure 2. Diurnal trend of xylem water potential (ψx) in *Gaylussacia baccata,* Lee Hill Bog and adjacent south-facing hillside. Stomatal diffusion resistance (r_S) is given in sec./cm. Vertical bars represent standard deviations.

available and xylem water potentials become appreciably low (more negative), as in the bog community, then internal resistances are indicated.

For steady-state flow through the plant, the transpiration flux is considered to be directly proportional to the water potential gradient and inversely proportional to internal flow resistances. Therefore, relating the measured xylem water potentials to the transpiration rate as estimated by the ratio VPD/r_s (for non-stress conditions) indicates that flow resistances within the bog plants may be higher than in the upland ecotypes. The rapid decrease of xylem potential with the commencement of transpiration in the bog plants gives some measure of the magnitude of the driving force (water potential gradient) needed to move water through the plant in the presence of high internal resistance.

Assuming that there is no resistance to water movement in the saturated peat soil, the resistances indicated for these bog plants may be considered to lie between the root-soil interface and the stem xylem tissue just beneath the leaf layer (the point at which the xylem water potential was measured). It is believed that poor soil aeration, a condition typical of bogs (see, for example, Armstrong and Boatman, 1967), inhibits root absorption, but is this alone enough to account for the resistance indicated here? Studies of Macklon and Weatherley (1965) suggest that root resistance plays little part in establishing leaf water potentials lower than -5 bars.

Flow resistances in the xylem, on the other hand, are generally considered to be the lowest in the soil-plant-atmosphere continuum. Increased resistance in the xylem may possibly result from decreased diameters of conducting elements or through the blocking of these by sclerids or tyloses, creating in effect a more tortuous translocation pathway in bog plants. Preliminary microscopic examination of the xylem tissue, however, showed vessel elements to be on the order of 15 to 25 microns in diameter, essentially the same as in the upland ecotypes and not small

enough to increase flow resistance, and revealed no obstructions in the vessels (Terrell Comstock, unpublished data). The source of the high internal flow resistances in bog plants, if indeed they exist, thus escapes recognition for the moment.

The values for VPD in this analysis were taken from the wet-bulb depression only (i.e., atmospheric VPD) which presupposes that the leaf and air were in thermal equilibrium. If leaf temperatures were elevated above air temperature, then the calculated values for VPD/r_s would be low. Presumably however, with all plants fully exposed, the direction of the error would be the same in all cases. Moreover, when it is considered that the water potential of the upland plants must also reflect flow resistances outside the plant, since it can be assumed that the soil adjacent to their roots is not saturated, then the relative differences in water potential levels seen here take on even greater significance with respect to indicated internal differences.

Of considerable interest in these data is the fact that the midday xylem potentials in the two *Gaylussacia* populations remained relatively close. This suggests the possibility of a closely regulated optimum water potential level for the species, indicating also very sensitive stomatal control, with the stomates of the upland plants closing before any detectable decrease in xylem water potential. This same phenomenon has been observed in yellow birch (C. A. Federer, personal communication) and is somewhat suggestive of the kind of direct response of stomates to evaporative conditions of the atmosphere, independent of leaf water potentials but conditioned by soil water supply, as reported by Schulze *et al.* (1972).

As for the question of xeromorphy in bog plants, leaf sclerophylly appears of advantage only insofar as it may be related to the evergreen habit, possibly preventing winter desiccation when water uptake is impaired. There is not enough evidence yet, however, to conclude that the water metabolism of bog plants is entirely similar to that of their upland counterparts. While Small (1972a) demonstrated

some similarity in the water status of woody plants in a bog and nearby mesic habitat, his mesic site was described as including a marsh and field adjacent to the bog and many of the species studied at that site, such as *Ilex verticillata* (L.) Gray, *Nemopanthus mucronata* (L.) Trel., and *Alnus rugosa* (DuRoi) Spreng. are typically confined to wetland areas. Lacking any data to the contrary, this suggests that the two environments may not have differed significantly in terms of soil-water availability. The data presented here indicate that dissimilarities in water metabolism between bog and upland ecotypes may indeed exist in relation to soil-water availability or other edaphic differences.

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THE DECIDUOUS MAGNOLIAS OF WEST FLORIDA

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The deciduous magnolias are perhaps the most distinctive relicts of the old Arcto-Tertiary forest. Pleistocene glaciation apparently eliminated these once-widespread plants everywhere from the temperate zone except in the eastern United States and in an arc stretching from Sikkim and Nepal to the Japanese Islands. Abundant rainfall, moderate temperatures, and rich mixed hardwoods seem essential for their greatest development in such regions as the southern Appalachians and the Cumberlands in this country. There *Magnolia acuminata* and *M. fraseri* contribute a minor though noteworthy element to the mixed mesophytic forests, growing alongside tuliptrees, hemlocks, lindens, buckeyes, and other characteristic species. In the lower valleys, especially along watercourses, *M. tripetala* and (in the Cumberlands) *M. macrophylla* display their huge leaves. Even the casual observer soon learns to associate the deciduous magnolias with our mountain forests in their cool, well-watered lushness. It may come then as a surprise to discover that each of these four eastern deciduous magnolias, either in itself or in a closely related species, can be found amid the predominantly piney woodlands of the Florida Panhandle.

This is not to suggest that these species can be found on the Coastal Plain only in West Florida, but that their remarkable collocation and the mode of their survival there in a presumably alien environment are of special taxonomic and ecological interest. This region differs from the rest of the lower Coastal Plain stretching from Virginia to eastern Texas mainly in its deeply incised terrain. The pine-covered uplands and the evergreen bays characterizing this zone are interrupted here and there by bluffs, steep-sided watercourses, and sharply rolling country, all of which provide

a foothold for a strongly deciduous and often surprisingly Appalachian plant assembly.[1] On these slopes, especially where the soil is rich and water-retentive, more northern genera such as *Fagus*, *Halesia*, *Oxydendrum*, and *Tilia* mix with such subtropical species as *Magnolia grandiflora* and *Quercus laurifolia*;[2] some of the riverbluffs supported American chestnut until quite recently (Elias, 1971).[3] The understory will often prove to be a thick tangle of the Appalachian *Kalmia latifolia* and the coastal bay-plant *Illicium floridanum*. In the calcareous regions, where the deciduous component is most prevalent, herbaceous plants such as *Trillium* and *Sanguinaria* put in an appearance. Throughout West Florida the indicator plant for such mesic sites is the silky camellia, *Stewartia malacodendron*.[4]

These anomalous patches of forest suggest a time, undoubtedly during a glacial epoch, when a deciduous forest covered much more of the area. Phytogeographers have long noted the more northerly elements in the ravine flora

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[1]See Thorne (1949) for a discussion of Appalachian species in the ravines of Southwest Georgia. E. L. Braun (1950) mentions the presence of a more deciduous element in the incised Tunica Hills section of eastern Louisiana.

[2]There seems to be some confusion about the proper nomenclature for the common "laurel oak" of the coastal zone. Kurz and Godfrey (1962) argue that this plant should be called *Q. hemisphaerica* Bartram. In this paper I have chosen to follow the conventional ascription of Preston (1961).

[3]Old-timers in Okaloosa and northern Escambia Counties recall the chestnut tree quite well. Unfortunately, the crowns do not seem to sprout as well as they do further north, and the frequency of chink-apins in the area keeps the blight pathogen in plentiful supply.

[4]Walter's pine (*Pinus glabra*) is also always present in these deciduous forests, but it is not a good indicator since it is also an element of what may be called the hammock association, a mixture dominated by this pine, *Magnolia grandiflora*, and the evergreen oaks *Quercus virginiana* and *Quercus laurifolia*. This climax association will eventually take over dry pine flats and ridges if the leaf litter is allowed to build up and if the woods are protected from fire and lumbering. The hammock association intergrades with the deciduous forests on more gradual slopes, especially where the soil is quite sandy.

of the famous Apalachicola River bluffs in Gadsden and Liberty counties, with their endemic *Torreya* and *Taxus* and such Appalachian species as *Cornus alternifolia*. A Florida endemic such as *Rhododendron minus* var. *chapmanii* also points to a time when the flora of the area was more like that of the southern highlands of the present day (see James, 1961). Apparently only steep and (often) north-facing terrain offered sufficient protection from the hot winds and intense insolation that favored the development of evergreen oaks and pines instead of deciduous woodlands. Only in these protected enclaves do the deciduous magnolias maintain their precarious Floridian existence.

In a few years clear-cut silviculture and residential sprawl may make fieldnotes on the adaptations of these plants to an alien environment unobtainable. The following observations on various species are offered for whatever ecological or taxonomic insights they may afford.

Magnolia ashei Weatherby

The status of this, the rarest of American magnolias, has been open to dispute since its description by C. A. Weatherby in 1926. Weatherby differentiates it from *Magnolia macrophylla* by rather comparative traits: a little less hair on the undersides of the leaves, smaller flowers and leaves, the smaller size of the plants. Only its rather narrow infructescence, as opposed to the strikingly globular one of *M. macrophylla*, offers any certainty to the identification of herbarium specimens (Kurz & Godfrey, 1962). I am personally very familiar with both plants, yet am not at all sure I would be able to distinguish a vigorous leaf or large flower of *M. ashei* from one of ordinary *M. macrophylla*. Even the variations in the purple blotches at the center of the flowers — something rather difficult to observe in herbarium specimens — seem to run through identical ranges in the two plants.

The two plants are quite separable in the field, however. *Magnolia macrophylla* is essentially a tree; it competes for space in the canopy in much the same way a hickory or a

sweetgum will do, though these taller-growing trees may eventually overtop it. The young plants are therefore remarkably upright, and blossoming occurs only on mature shoots high above the ground. The collector who wishes to examine a *M. macrophylla* flower must locate either an isolated horticultural specimen or one released by clearing or roadbuilding. *Magnolia ashei* on the other hand behaves as a large, coarse shrub that seldom climbs out of the understory. It competes for light in the manner of the deciduous azaleas, by leaning toward holes in the canopy and by taking on a loose-jointed, often horizontal growth form. On rare occasions an individual specimen will become what might be termed a tree, but that plant will hardly ever exhibit the clean upward sweep of the average *M. macrophylla*. Though the plant's crowns sprout vigorously, individual shoots of *M. ashei*, from the evidence of all the dead wood, seem to be quite short-lived, and the species apparently is incapable in the wild of that sustained development on a single shoot necessary for competition in the upper layers of the forest. Horticultural specimens of *M. macrophylla* grow continuously from a single bole if undisturbed; *M. ashei* specimens can hardly be kept from coppicing.

Magnolia ashei seems to have adapted to its existence as a shrub by assuming a tolerance for shade and by blooming in the understory. The plant is remarkably free-flowering at small sizes; in the wild I have observed small shoots (ca. 1 meter) capped by a blossom while standing in the dense shade of *Quercus laurifolia*. In cultivation, the plant becomes strikingly floriferous. One in my care has set blooms on coppice shoots less than 10 cm. tall, and another has borne five blossoms on a single branched shoot not one meter tall or half a meter across. Such behavior in *M. macrophylla* is, to the best of my knowledge, unheard-of.

The present-day ranges of these two plants preclude genetic exchange. In Alabama I have never observed *Magnolia macrophylla* south of the rolling limestone hills stretching from northern Mobile County to Monroeville

and then eastward. In Mississippi and Louisiana the plant goes further south into areas underlain by more recent Tertiary formations, but along the Alabama-Florida border only a few north-south river valleys and bluffs interrupt the sterile Citronelle (late Pliocene or early Pleistocene) and later Pleistocene deposits blanketing the terrain. Neither taxon seems to have invaded the few upland hardwood areas in this region, possibly because both prefer rather more calcareous soils. I have never seen *M. ashei* north of the line traced by U. S. Highway 90.

The center of distribution of *Magnolia ashei* seems to be the Knox Hill region in eastern Walton County. In this strongly rolling area the sterile overburden is replaced by a dark, rich, water-retentive clay or loam derived from distinctly calcareous marl.[5] The plant is actually common on a few square miles surrounding Knox Hill. To the east it can be found on hills and along watercourses near Vernon, Washington County (geologically a rather similar area); on limestone hills along Econfina Creek in northern Bay County; on high slopes along the east bank of the Ochlockonee River near Smith Creek, Wakulla County; and on the Apalachicola bluffs between Bristol and Chattahoochee. The stations a few miles south of Chattahoochee bring *M. ashei* closest to *M. macrophylla*: patent *M. macrophylla* may be found in the ravines south of Ft. Gaines, Georgia, some 50 miles to the north. As best I can discover, the southern border of Clay County, Georgia, marks the southernmost extension of *M. macrophylla*, so intergradation seems highly unlikely.[6] It may be of interest that two other separable but closely related taxa, *Rhododendron minus* and its Florida form, *R. minus* var. *chapmanii*, reach their

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[5]The region contains rich collecting spots for Miocene shells of the Alum Bluff series. See Cook and Mosson (1929). Harper (1914) describes the soil and vegetation of this area.

[6]At least in Georgia. I am much less familiar with the southeastern corner of Alabama, so intermediates could conceivably be found in Henry or Houston counties. If they are there, however, they are elusive.

southernmost and northernmost stations within less than 10 miles of the comparable stations for *M. macrophylla* and *M. ashei*.

To the west of the Knox Hill region, *M. ashei* inhabits occasional very precipitous ravines and steepheads within Eglin Air Force Reservation. The westernmost station lies just off State Highway 87, about 20 miles east of Pensacola. It was from this region that W. W. Ashe obtained the series upon which Weatherby based his description of the species. Oddly enough, the soil on these slopes is sandy and apparently sterile, quite unlike the heavy soil of stations to the east. The deciduous element of the attendant vegetation is also attenuated, with *Fagus* notably absent, though *Ostrya*, *Oxydendrum*, and *Stewartia* are almost always present. *Gordonia lasianthus* is quite frequent along these streams.[7]

Magnolia ashei is thus probably a relict that through isolation has adapted to life as a shrub rather than a tree. The plant inhabits mixed evergreen and deciduous forests, and indeed the dense canopy offered by the evergreen magnolia and the evergreen oaks may have precluded competition in the manner open to *M. macrophylla* in regions where these evergreen hardwoods are not so common. Except in a few square miles the plant is remarkably rare; a comparably vulnerable, unusual, and attractive bird or mammal would surely have been the occasion for dozens of pilgrimages and popular articles.

[7]The presence of *Magnolia ashei* in East Texas has been reported. Several years ago I observed a big-leafed magnolia in the yard of a gentleman living at "Devil's Pocket," a rather flat, swampy region in southern Newton County. He said this transplanted specimen was all that remained of an older plant that once stood in his pasture on a hammock. The plant has since died, so I have been unable to re-examine the specimen in the light of my field experience with Florida *M. ashei*. As I recall, the plant bore reduced leaves, but the form was definitely upright in a manner I later learned to associate only with *Magnolia macrophylla*. I saw no infructescences. Several years of searching and conferring have failed to turn up a single other plant in that county or in Texas. *Magnolia macrophylla*, it might be noted, is fairly common in adjacent western Louisiana.

MAGNOLIA ACUMINATA L.

Magnolia acuminata is a more decidedly Appalachian plant than *M. macrophylla,* yet it occurs in West Florida, perhaps in the form of *M. acuminata* var. *subcordata.* The distinction between the typical variety and var. *subcordata* seems more plausible to the reader of taxonomic keys than to the observer in the field, since great variations in hairiness and flower color may occur within a given locality (see Hardin, 1954). In general, the West Florida plants bear greenish-yellow flowers intermediate between the showy canary-yellow blooms of some plants in piedmont Georgia and the greenish forms prevalent in the higher mountains. Although the hairiest leaves I have ever seen on any cucumber-tree grew on a Florida specimen, closeby trees bore leaves indistinguishable from those on central Mississippi and northern Alabama plants. As with many other species, hairiness seems to increase gradually though irregularly southward, as water loss from the leaves becomes more and more of a threat to survival. I wonder if the cucumber-trees would be split at all if it were not for the historical accident that a singularly yellow form existed as a horticultural curiosity for almost a century until the piedmont Georgia plants were relocated by Berckmans in 1913 (Sargent, 1933).

In Florida *Magnolia acuminata* is to be found only in the Knox Hill region mentioned in the previous discussion. It is much less frequent there than *M. ashei,* however, growing only in a narrow band marking the transition between beech and hickory woods along a few ravines and slopes in the richest areas. There it becomes a fairly large tree. Kurz and Godfrey (1962) report that a search of the area located only six trees. Though I have located several hundred, distribution is sporadic and the trees are easily missed without a meticulous search in rather difficult country.

The Citronelle deposits mentioned earlier separate these Florida plants from the closest Alabama cucumber-trees,

a large population inhabiting the Sepulga River valley to its mouth in upper Escambia County, Alabama. The mouth of the Sepulga marks the southernmost outcropping of Oligocene limestone in that part of the state, so calcareous soil again seems to be the key to distribution. The limestone region in the Panhandle near Marianna and Tallahassee apparently does not support cucumber-trees, but then cucumber-trees are either exceedingly rare or entirely absent in immediately adjacent Alabama and southwestern Georgia. Southwestern Alabama and southern Mississippi, on the other hand, are replete with cucumber-trees. Possible reasons for this anomaly elude me.

Genetic isolation seems to have resulted in no genetic drift: trees from western Florida and southern Alabama occupy virtually identical sites and, from every appearance, are indistinguishable. *Magnolia acuminata* seems to be an intermediate in the plant succession — like sweetgum, say — whereas *M. ashei* is a more stable component of what seems to be a climax association. Its extremely rapid growth, handsome foliage, and tolerance for drought would make the coastal strain a fine shade tree for use in the lower South.

MAGNOLIA PYRAMIDATA Bartr.

This is the most common deciduous magnolia in West Florida. *Magnolia pyramidata* can be found in beech woods and on deciduous slopes throughout the area, both in the rich Knox Hill region and on the less fertile streambanks and bluffs along the Alabama line. Very steep north-facing slopes are its most typical habitat, where it can often be found amid mountain laurel thickets.

Magnolia pyramidata is the coastal equivalent of *M. fraseri* of the mountains. Whether these are separable either as species or as varieties is a moot question. Certainly if typical *M. acuminata* and *M. acuminata* var. *subcordata* are to be separated, these two plants should also be. On occasion, the mountain plant becomes a fair-sized tree with

a thick, low-branched bole; the Florida plant is much smaller, with an ascending form and (usually) a single trunk. I do not remember ever seeing a bole bigger than 10 cm. in diameter in West Florida. The leaves of the mountain plants tend to be much larger, also, though occasionally vigorous Florida specimens will belie the published keys. In East Texas (Jasper and Newton counties) putative *M. pyramidata* at times resembles *M. fraseri* in the size of leaves and the form and size of the trees, and is found, oddly enough, only on the top of a few sandy ridges; no one familiar with *M. pyramidata* in Florida could guess where to seek the Texas colonies. There is a gradual transition between *M. pyramidata* of Florida and *M. fraseri* of the mountains, since the Alabama and Georgia plants form a continuous sequence from north to south in these states.

In Florida this plant is occasional and hardly ever produces what might be termed colonies. The plant is by no means uncommon, however, and a belief that it is reflects not the state of nature but our limited knowledge of the complexities of coastal vegetation. Like *Stewartia malacodendron,* which is often termed rare in handbooks, *M. pyramidata* seems quite frequent once its habitat is understood and sought out.

MAGNOLIA TRIPETALA L.

This is apparently the first record of the occurrence of this magnolia in Florida. So far I have found it only along about half a mile of high north-facing bluff and in a contiguous ravine system on the Shoal River, approximately two miles west of Dorcas, Okaloosa County. This particular section is steep, but no more so than several other bluffs and ravines along the Shoal and nearby Yellow rivers. The bluffs are composed of Miocene marl, and the segment bearing *M. tripetala* does seem to be covered by an unusual quantity of redbud (*Cercis canadensis*), which in Florida is a good indicator of limy soil. The ravine system itself, where perhaps 95% of the *M. tripetala* plants grow, is

a delightfully unspoiled area, with two small springfed streamlets running over large blocks of marl, uncut hardwoods such as beech and white oak and linden, an interesting herbaceous layer, and here and there the big leaves of the magnolias. This surprising and isolated stand of this species is so small it could easily be destroyed entirely by clearing or even lumbering.

The closest extensive colony of *Magnolia tripetala* on the Coastal Plain seems to be located on the north-facing bluffs along Hog Creek, Randolph County, Georgia. There *M. tripetala* is a vigorous competitor in the subcanopy, resembling in form and habit the specimens of *M. macrophylla* with which it grows; in competition with *M. macrophylla* it seems to favor the very steepest bluffs and the deepest and darkest ravines. The Florida plants, on the other hand, grow in a better-lighted area and mix with an understory of *Stewartia* and small dogwood and redbud trees — the last of which is certainly not a remarkably tolerant species. I have observed no stem more than 6 or 8 cm. in diameter, nor is any plant more than 10 meters tall. The great majority are between 3 and 5 meters.

Though an analogy to the reduced stature of *Magnolia ashei* suggests itself, it seems likely that reduced vigor rather than genetic divergence accounts for the difference between ordinary *M. tripetala* and the Florida plants. For one thing, there are dead stems leading from a high percentage of the crowns, so perhaps the leaders cannot survive long enough to grow into a well-developed tree. The form of the plant is upright, unlike the horizontal tendency of the truly shrubby *M. ashei*. Most significantly, they show none of the ability of *M. ashei* to bloom vigorously at a small size, and that would surely be a necessary concomitant to a genuine adaptation to existence as a shrub. In fact, no *M. tripetala* seedlings could be discovered in a rather meticulous search; only sprouts upon older rootstocks were discovered. The plants do show one singular habit, however. Approximately half the clumps are attended (at a distance of a meter or so) by one or more small satel-

lite plants which can be traced by what appear to be horizontal runners back to the central crown. I have never observed this tendency to spread by vegetative means in other magnolias, and a check of the Hog Creek colony has revealed only a few sprouts which might be thought comparable. At the present time I am cultivating several of the Florida offsets in hopes of comparing their behavior with a seedling *M. tripetala* taken from a vigorous colony found in coastal North Carolina near New Bern.

Other stations close to the Shoal River colony seem to be (1) on the Pascagoula River in southern Mississippi and (2) in Butler County, Alabama (W. H. Duncan, personal communication). Since I have, unfortunately, never located either station, I cannot comment on the vigor or habitat at other locations on the southern coastal plain.

This deciduous magnolia seems to be the ultimate example of an Arcto-Tertiary relict which has persisted in an island of mesophytic forest on a protected north-facing slope amid the pinewoods of Florida. How long this colony has been there or whether it is the remnant of a larger colony would be impossible to say. For some time now it may even have been regenerating itself almost entirely by vegetative means. Its chances of surviving the chain saw and the log sledder and the bulldozer seem easier to estimate. It does seem unfortunate, though, that all that will remain of such a dogged adaptation to an alien environment will be a few dried sheets in a herbarium and an aberrant dot on a map.[8]

[8]Specimens of the plants discussed in this article have been deposited in the herbarium of the University of Georgia. In particular, I would like to express my appreciation to its director, Professor Wilbur H. Duncan, for his unfailing generosity with his expertise and for his remarkable tolerance for amateur enthusiasm.

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INVESTIGATIONS OF NEW ENGLAND MARINE ALGAE VII: SEASONAL OCCURRENCE AND REPRODUCTION OF MARINE ALGAE NEAR CAPE COD, MASSACHUSETTS[1, 2]

DOUGLAS C. COLEMAN AND ARTHUR C. MATHIESON

In an earlier paper (Coleman and Mathieson, 1974) we described the horizontal distribution of seaweeds at seven sites from Scituate to Woods Hole, Massachusetts, including the Cape Cod Canal. In the following account we summarize the seasonal occurrence and reproduction of seaweeds at the same locations. Most previous collections and observations of Cape Cod seaweeds have been restricted to the summer. Conover (1958) and Sears (1971) have conducted the only detailed seasonal investigations of Cape Cod marine algae. Conover described the productivity and seasonal composition of the algae in the Great Pond Estuary of Falmouth in relation to a variety of environmental parameters. Sears described the subtidal benthic algae at several sites in southern Cape Cod. Neither Sears nor Conover gave any consideration to the seaweeds in the Cape Cod Canal, which connects Cape Cod Bay and Buzzards Bay. The Canal is a transitional zone separating two distinctive water masses and marine floras (Coleman and Mathieson, 1974). The temperature discontinuity between the two sides of the Cape may reach 10°C. during the summer; thus, Cape Cod is one of the major phytogeographical boundaries on the Atlantic Coast of North America (Farlow, 1870, 1882; Harvey, 1852-1858; Humm, 1969, Setchell, 1922).

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[1]Published with the approval of the Director of the University of New Hampshire Agriculture Experiment Station as Scientific Contribution Number 665.

[2]Jackson Estuarine Laboratory Contribution No. 14.

Monthly collections and observations of marine algae were made at each of the seven sites (Fig. 1) during 1969. Specific details of collections, identifications, and descriptions of stations have been previously summarized (Coleman and Mathieson, 1974), and they will not be repeated in the present paper.

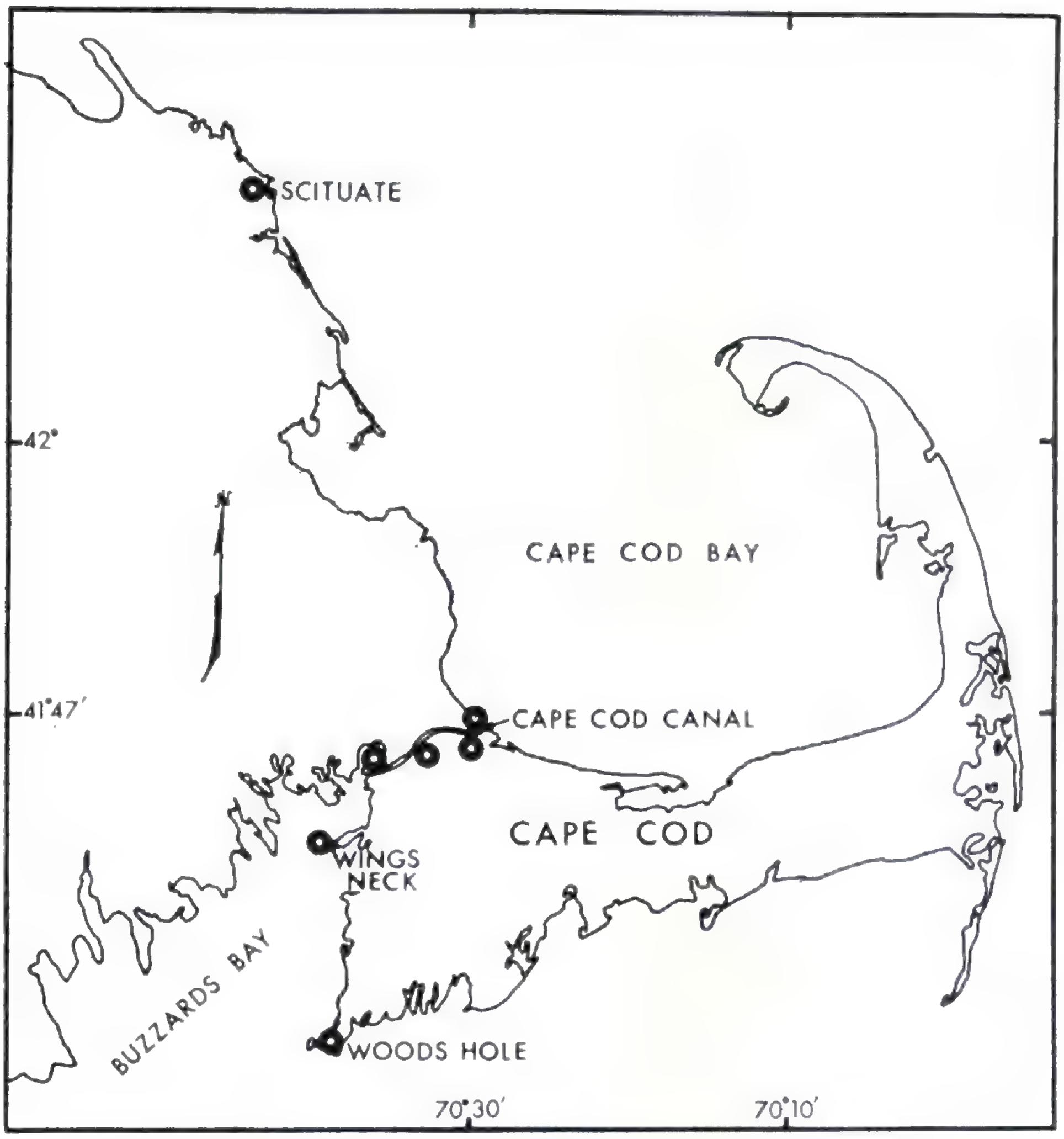

Figure 1. Map of Cape Cod, Massachusetts, showing the seven stations.

SEASONAL OCCURRENCE AND LONGEVITY

Figures 2 and 3 summarize the monthly occurrence of seaweeds at each station. There was a conspicuous increase in the number of species during the spring and summer, except at stations 2, 3, and 4. The time of peak numbers

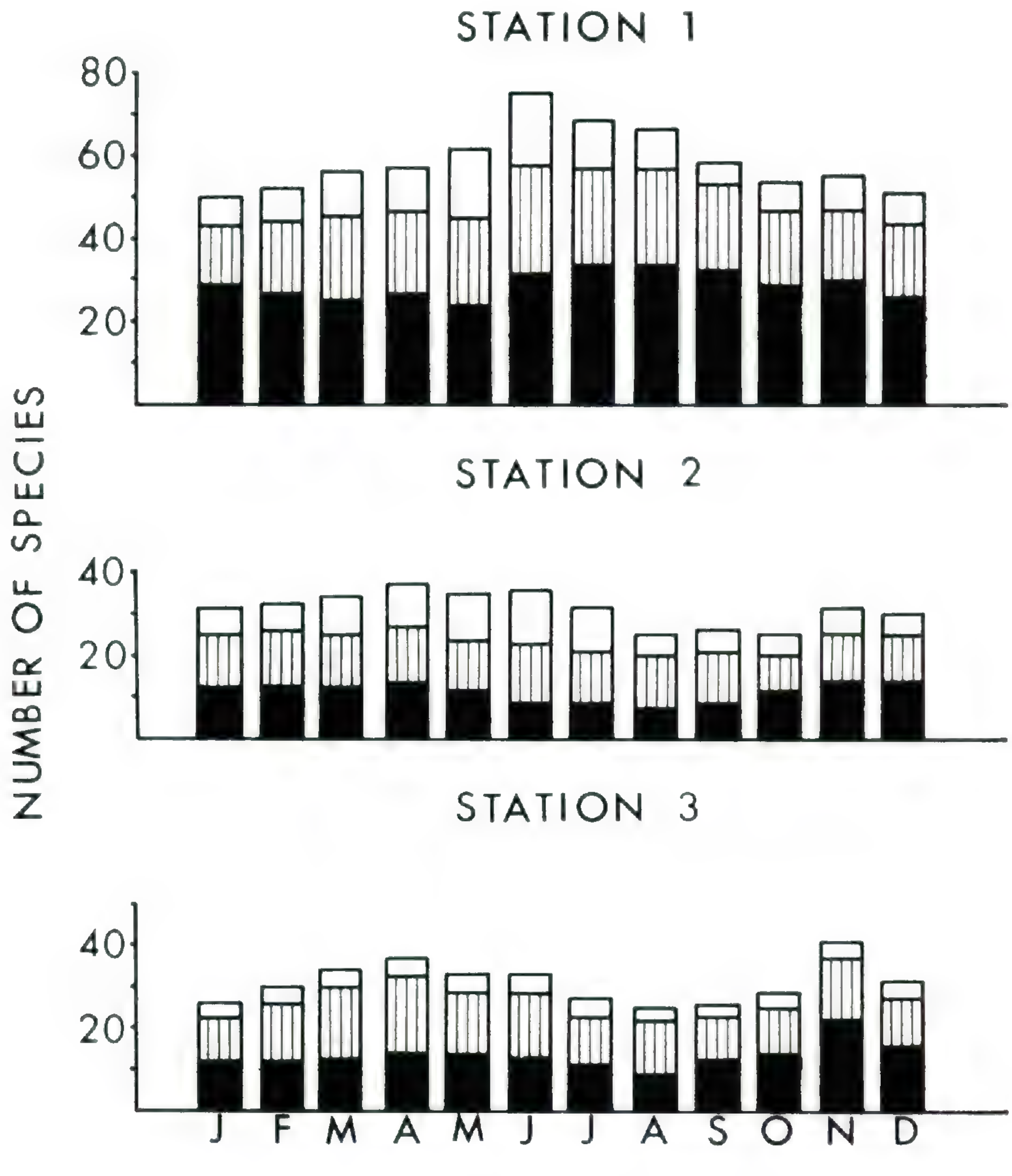

Figure 2. Monthly variation in number of species at stations 1-3. Black = red algae; hatched area = brown algae; white = green algae.

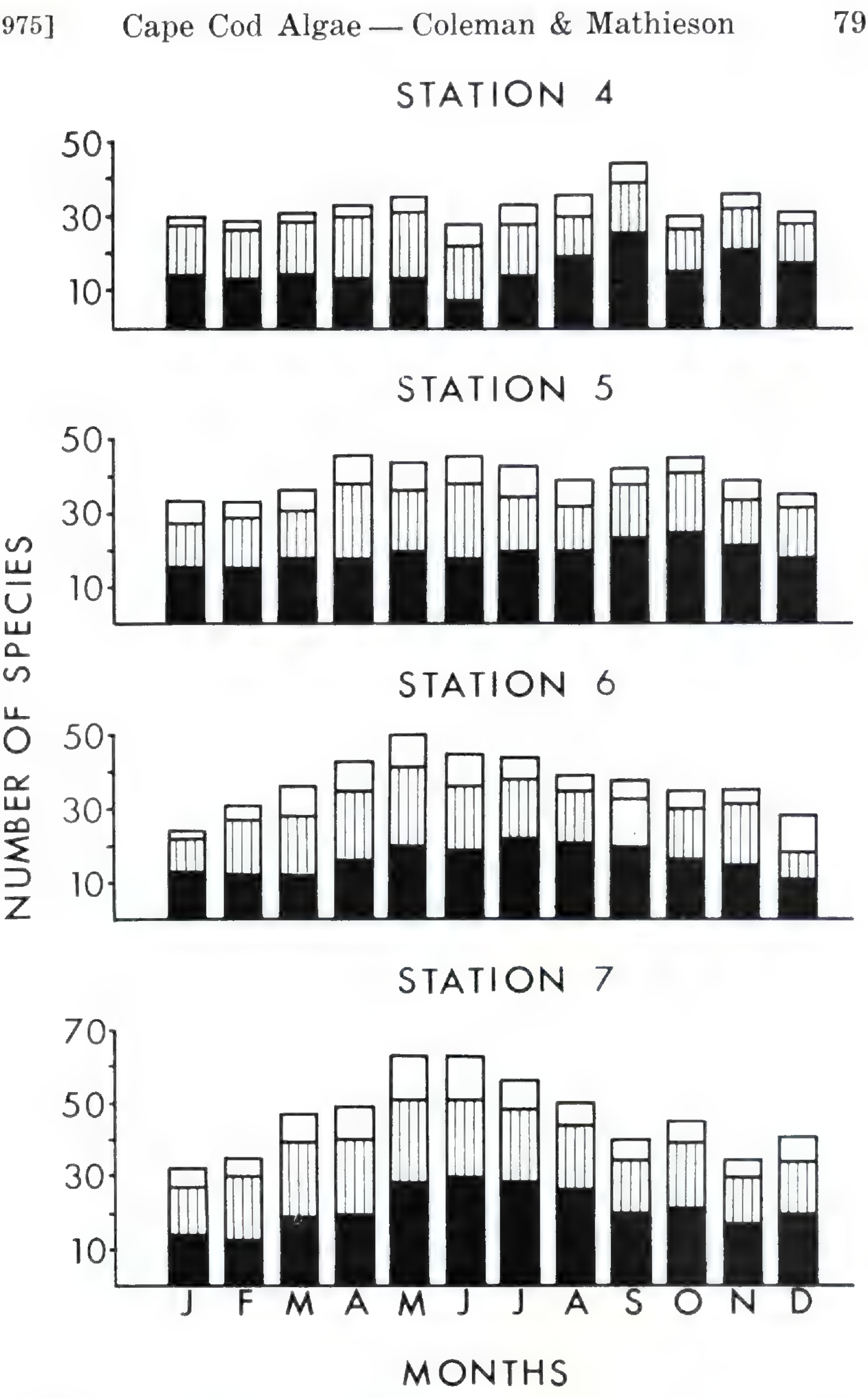

Figure 3. Monthly variation in number of species at stations 4-7. Black = red algae; hatched area = brown algae; white = green algae.

varied at different stations. Seasonal changes were usually most obvious from January to June, except at stations 3 and 4. A gradual decline in the number of species was observed from June to December at each station. The majority of species at each site belonged to the Rhodophyta and Phaeophyta; the lowest numbers were members of the Chlorophyta. The red algae showed a greater increase in numbers during the spring and early summer than did either the browns or greens. Seasonal changes in numbers were greatest at Scituate, Wings Neck and Woods Hole. See Tables I-III for specific details of occurrence at stations 1, 4 and 7 — i.e., a northern, a southern, and a Canal station.

Of the 106 taxa collected at the seven stations, 49 were designated as annuals and 57 as perennials (Table IV). Perennials accounted for the largest number of species at each station, except at Wings Neck and Woods Hole. The ratio of annuals : perennials at each station was as follows: station 1 — 42 : 58, station 2 — 44 : 56, station 3 — 40 : 60, station 4 — 42 : 58, station 5 — 43 : 57, station 6 — 54 : 46, station 7 — 54 : 46. The conspicuous annuals and perennials on each side of the Cape are summarized in Tables V and VI. The dominance of annuals and reduced numbers of perennials to the south is apparent.

Three groups of perennials can be distinguished as follows, depending upon their abundance north and south of the Cape: 1) species either restricted to or more abundant north of the Cape; 2) species either restricted to or more abundant south of the Cape; 3) species common on both sides of the Cape. The first group included *Choreocolax polysiphoniae, Gigartina stellata, Petrocelis middendorfii, Plumaria elegans, Fucus distichus* ssp. *distichus* and *Chaetomorpha atrovirens.* The second group included *Callithamnion baileyi, Sargassum filipendula,* and *Codium fragile* ssp. *tomentosoides.* The last group included *Ceramium rubrum, Chondrus crispus, Corallina officinalis, Sphacelaria cirrosa* and *Chaetomorpha linum.*

Distinct winter, spring and summer annuals were evident at the seven sites. The first group included *Bangia*

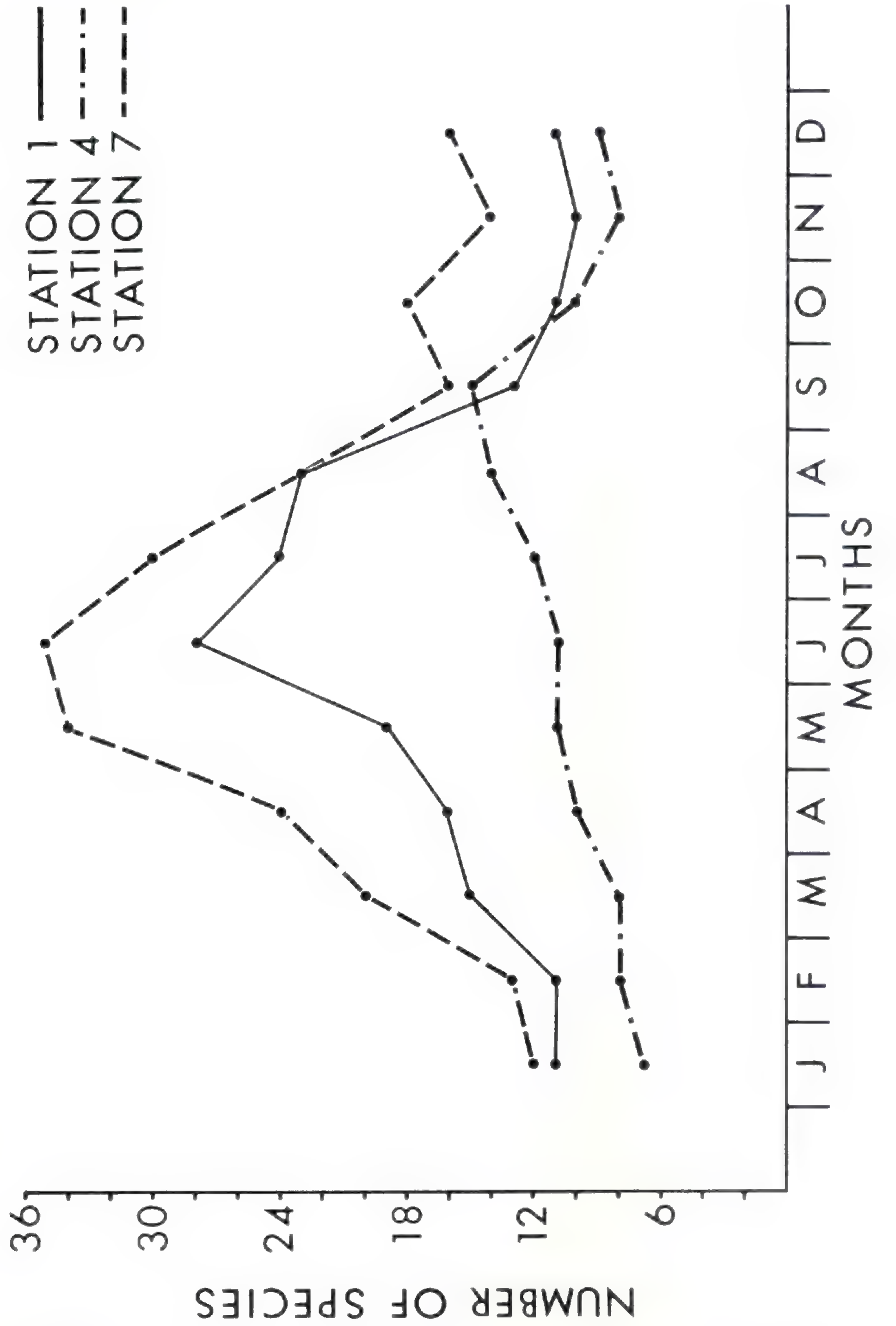

Figure 4. Monthly variation of annuals at stations 1, 4 and 7.

fuscopurpurea, *Petalonia fascia* and *Codiolum gregarium*. The second group included *Desmarestia viridis*, *Desmotrichum balticum*, *Punctaria plantaginea*, *Enteromorpha linza*, *Monostroma grevillei* and *Monostroma pulchrum*. The third group included *Dasya pedicellata*, *Champia parvula*, *Chondria sedifolia*, *Grinnellia americana*, *Hypnea musciformis* and *Seirospora griffithsiana*. Figure 4 illustrates the monthly number of annual species at stations 1, 4 and 7. The largest number of annuals occurred during the spring and summer months, except at station 4, and a decrease was evident during the winter months.

Differential, spatial, and seasonal successions of annuals were recorded north and south of the Cape. Three patterns of seasonal succession were evident (Table VII). Some species occurred earlier south than north of the Cape, others disappeared earlier south than north, while a third group was found throughout the year on both sides of the Cape. Some examples of differential spatial succession may also be noted. The winter annuals *Bangia fuscopurpurea* and *Petalonia fascia* appeared simultaneously in the Canal and on the south shore of the Cape, but they were not found at Scituate until several weeks later. Other spring and summer annuals such as *Ceramium strictum*, *Agardhiella tenera*, *Lomentaria baileyana*, *Chorda filum* and *Leathesia difformis* appeared successively at Woods Hole, the Canal stations and finally at Scituate.

SEASONAL REPRODUCTION

Species common to both sides of the Cape showed differences in reproductive periods (Tables I-III). The annuals can be divided into three groups as follows according to their reproductive patterns: 1) species reproducing earlier south than north of the Cape; 2) species terminating reproduction earlier south than north of the Cape; 3) species reproducing throughout the year north of the Cape, but with limited reproductive periods to the south. Examples of each group are as follows: 1) *Agardhiella tenera*,

Chorda filum, *Leathesia difformis*, *Ceramium strictum*, *Chordaria flagelliformis*, and *Asperococcus echinatus*; 2) *Bangia fuscopurpurea*, *Dumontia incrassata*, *Porphyra umbilicalis*, *Leathesia difformis*, *Petalonia fascia*, and *Monostroma grevillei*; 3) *Porphyra umbilicalis*, *Petalonia fascia*, and *Scytosiphon lomentarius*. Table VIII summarizes all of the species found in each group.

The perennials can also be divided into three groups according to their reproductive patterns: 1) species primarily reproducing during the colder months; 2) species primarily reproducing during the warmer months; 3) species reproducing throughout the year. Examples of each of the groups are as follows: 1) *Chondrus crispus*, *Petrocelis middendorfii*, *Laminaria* spp., and *Polyides rotundus*; 2) *Callithamnion baileyi*, and *Cystoclonium purpureum* var. *cirrhosum*; 3) *Ascophyllum nodosum*, *Fucus* ssp., *Pilayella littoralis*, *Sphacelaria cirrosa*, and *Ahnfeltia plicata*. The generalized groupings of species according to reproductive periods were not always consistent at all stations. For example, *Pilayella littoralis* and *Chondrus crispus* had an extended reproductive period north of the Cape, but exhibited limited periods of reproduction to the south. See Tables I-III for specific details of reproduction at stations 1, 4 and 7.

DISCUSSION

Davis (1913a, b) suggests that the wide range of temperatures near Cape Cod results in distinct annual populations. He distinguishes two groups of annuals as follows: (1) winter-spring, and (2) mid-summer or early autumn. We observed four types of annuals: winter, spring, summer and aseasonal. Sears (1971) also recorded aseasonal annuals during his study of the subtidal marine algae in southern Cape Cod. The latter group showed no seasonal specificity; the plants reproduced throughout the year and they were represented by successive generations of young plants. Among others, Davis (1931a, b), Setchell (1920),

Williams (1948) and Chapman (1964) state that species may survive adverse temperatures in a resting stage. Sears' (1971) observations substantiate the latter suggestion, for he observed germlings of several red algae overwintering in the deep subtidal zone off Martha's Vineyard, Massachusetts.

Cold water perennials might be expected to enter a comparable state during the warmer months. Setchell (1917) states that the northern fucoid alga *Ascophyllum nodosum* enters a heat labor state during the summer south of the Cape. We have observed a similar response for *A. nodosum* south of the Cape, for it becomes bleached and unhealthy looking during the summer.

The ratios of annuals to perennials varied at different stations. North of Cape Cod perennials were dominant, while to the south annuals were more abundant. Intermediate ratios were found in the Canal. The seasonal temperature regimes at the seven sites are correlated with the percentage of annuals and perennials at each site. Thus, the temperature range south of the Cape is about 22°C., while to the north it is about 17°C.; intermediate values are evident in the Canal (Coleman and Mathieson, 1974). The high summer temperatures south of the Cape allow warm temperature annuals to occur in abundance. In contrast the winter flora at the same sites is dominated by northern (boreal) annuals. Williams (1948, 1949) has recorded a similar seasonal variation of annuals at Cape Lookout, North Carolina. He emphasizes that areas with wide temperature fluctuations, such as Cape Lookout, support a wide range of annuals.

Geographical differences of seasonal succession were evident. For example, warm water annuals occurred earlier south of the Cape than north, while many cold water annuals remained longer north than south of the Cape. The early appearance of warm water annuals south of the Cape resulted from higher spring temperatures in Buzzards Bay than Cape Cod Bay. Likewise, some cold water annuals remained longer north of the Cape, because of the lower

spring temperatures in Cape Cod Bay. It is suggested that differences in seasonal successions at the stations are primarily dependent on temperature differentials.

Variable reproductive periodicities were also evident for the same species at different stations. For example, several warm water annuals initiated reproduction earlier south than north of the Cape, while cold water annuals reproduced longer north than south. The reproductive patterns of perennials also showed similar patterns as the annuals, again indicating the importance of temperature differences.

Acknowledgements

We would like to thank Dr. A. Hodgdon for his critical review of the manuscript. In addition we express our gratitude to Dr. R. Fralick, Dr. R. Turner and Mr. John Hansman for their assistance with diving and collection of specimens, and to the Army Corps of Engineers at Cape Cod for diving access to the Cape Cod Canal.

LEGEND: TABLES I-III — a = alpha spore, b = beta spore, C = carpospore, G = gametangia, M = monospore, PS = plurilocular sporangium, R = receptacle, S = spermatium, T = tetraspore, US = unilocular sporangium, Z = zoospore, X = present, — = absent.

TABLE I. SEASONAL OCCURENCE AND REPRODUCTION OF SPECIES AT STATION 1

Rhodophyta

TAXON	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
Agardhiella tenera	—	—	—	—	—	X	—	—	—	—	—	—
Ahnfeltia plicata	M	M	M	M	X	M	M	M	M	M	X	M
Bangia fuscopurpurea	M	M	X	X	X	M	X	—	—	—	X	M
Callithamnion baileyi	—	—	—	—	—	—	X	T	—	—	X	—
Callithamnion roseum	—	—	—	—	—	X	X	—	—	—	—	—
Ceramium rubrum	X	X	T	T	X	X	T	T,C	T	T	X	X
Ceramium strictum	—	—	—	—	—	—	X	X	X	—	—	—
Chrondrus crispus	X	X	C	C	C	C	C	C	C	C	X	C
Choreocolax polysiphoniae	X	X	X	X	X	X	X	—	X	X	X	X
Clathromorphum circumscriptum	X	X	X	X	X	X	X	X	X	X	X	X
Corallina officinalis	X	X	X	X	X	X	X	X	X	X	X	X
Cystoclonium purpureum var. *cirrhosum*	X	X	X	X	X	X	T	T	T	T	T	X
Dermatolithon pustulatum	X	X	X	X	X	X	X	X	X	X	X	X
Dumontia incrassata	X	X	X	T	T	T	X	T	X	X	X	X
Gigartina stellata	C	C	C	C	X	X	C	C	C	C	C	C
Gloiosiphonia capillaris	—	—	—	—	—	X	X	X	—	—	—	—
Hildenbrandia prototypus	X	T	T	T	T	T	T	X	X	T	T	T
Lithophyllum corallinae	X	X	X	X	X	X	X	X	X	X	X	—
Lithothamnium graciale	X	X	X	X	X	X	X	X	X	X	X	X
Lomentaria baileyana	—	—	—	—	—	—	X	T	T	—	—	—
Melobesia lejolisii	—	—	—	—	—	X	X	X	X	X	X	X
Petrocelis middendorfii	T	T	T	T	X	T	X	X	X	X	X	X

TABLE I. — Rhodophyta (continued)

TAXON	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
Phyllophora brodiaei	M	M	X	X	M	M	M	X	X	X	X	M
Phyllophora membranifolia	T	T	T	T	X	X	X	X	X	T	X	T
Phymatolithon lenormandi	X	X	X	X	X	X	X	X	X	X	X	X
Plumaria elegans	X	X	X	X	X	X	X	X	—	X	X	X
Polyides rotundus	X	T	X	X	X	X	X	X	X	X	T	T
Polysiphonia dunudata	—	—	—	—	—	—	—	X	X	X	—	—
Polysiphonia harveyi	—	—	—	—	—	—	X	X	T	T	—	X
Polysiphonia lanosa	S	S	S	S	X	C	T,C	T	T,C	T,C	T	T
Polysiphonia nigrescens	X	—	X	—	—	T	T,C	T,C	C	T	T	T
Polysiphonia novae-angliae	T	T	—	X	—	—	—	—	X	—	X	—
Polysiphonia urceolata	X	X	—	X	—	T	—	T	T	—	T	T
Porphyra miniata	—	—	—	—	—	—	X	X	—	—	—	—
Porphyra umbilicalis	a	a	a,b	X	a	X	b	a,b	a	X	a,b	X
Rhodochorton penicilliforme	X	X	X	X	—	X	X	X	—	X	X	X
Rhodomela confervoides	X	X	X	X	T	T,C	T	T	X	X	X	X
Rhodymenia palmata	T	T	T	T	T	X	X	T	X	X	T	T
Trailliella intricata	—	—	—	—	—	—	—	X	X	—	—	—

Phaeophyta

TAXON												
Ascophyllum nodosum	R	R	R	R	R	R	R	R	R	R	R	R
Asperococcus echinatus	—	X	X	US	US	US	X	X	—	X	—	X
Chorda filum	—	—	—	—	—	X	US	US	US	—	—	—
Chorda tomentosa	X	X	X	US	US	X	X	—	—	—	—	—

TABLE I. — Phaeophyta (continued)

TAXON	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
Chordaria flagelliformis	X	X	X	X	X	US	US	X	US	X	US	X
Desmarestia aculeata	X	X	X	X	X	X	X	—	X	US	X	X
Desmarestia viridis	—	—	—	—	X	X	X	X	—	—	—	—
Desmotrichum balticum	—	—	—	—	—	PS	—	X	—	—	—	—
Dictyosiphon foeniculaceus	X	X	X	X	X	X	X	X	X	X	X	—
Ectocarpus siliculosus	X	—	—	—	—	PS	X	X	X	X	X	—
Elachista fucicola	X	X	X	X	X	X	US	US	X	US	US	US
Fucus distichus ssp. *distichus*	—	—	R	R	R	X	X	X	X	X	X	X
Fucus distichus ssp. *edentatus*	R	R	R	X	X	R	R	—	R	R	R	R
Fucus distichus ssp. *evanescens*	—	—	—	—	—	R	R	X	X	X	—	—
Fucus spiralis	R	X	X	R	R	R	R	X	R	R	R	X
Fucus vesiculosus	R	R	R	R	R	R	R	X	X	X	R	R
Laminaria digitata	US	US	US	US	X	X	X	X	X	X	X	US
Laminaria saccharina	US	US	US	X	X	X	X	X	X	X	US	US
Leathesia difformis	—	—	—	—	—	X	US	US	—	—	—	—
Myrionema strangulans	X	X	X	X	X	X	—	—	X	—	X	X
Petalonia fascia	PS	PS	PS	PS	PS	X	X	X	PS	PS	PS	X
Punctaria latifolia	—	—	—	—	—	X	—	—	—	—	—	—
Pilayella littoralis	US,PS	US,PS	US,PS	US,PS	US,PS	US,PS	US,PS	US,PS	US,PS	US,PS	X	X	X
Ralfsia fungiformis	—	X	X	X	X	X	X	X	X	X	—	—
Ralfsia verrucosa	—	—	US	US	US	US	US	US	US	US	US	—
Scytosiphon lomentarius	PS	PS	PS	PS	PS	PS	—	PS	PS	X	X	PS

TABLE I. — Phaeophyta (continued)

TAXON	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
Sphacelaria cirrosa	X	X	X	X	X	P	P	P	P	P	P	X

Chlorophyta

TAXON												
Chaetomorpha atrovirens	X	X	X	—	X	X	X	X	X	X	X	X
Chaetomorpha linum	X	X	X	X	X	X	X	X	X	X	X	X
Chaetomorpha melagonium	—	X	X	X	X	X	X	X	—	X	X	X
Cladophora flexuosa	—	—	—	—	X	X	X	X	X	—	—	—
Cladophora gracilis	—	—	—	—	X	X	X	X	—	—	—	—
Codiolum petrocelidis	—	—	—	—	—	X	X	X	—	—	—	—
Codiolum gregarium	—	—	—	—	—	—	X	X	—	—	—	—
Enteromorpha intestinalis	X	X	X	X	X	X	X	X	X	X	X	X
Enteromorpha linza	—	—	—	—	X	X	—	—	—	—	—	—
Monostroma grevillei	—	—	X	G	X	X	—	—	—	—	—	—
Monostroma pulchrum	—	—	X	X	G	X	—	—	—	—	—	—
Rhizoclonium tortuosum	X	X	X	X	X	X	X	X	X	X	X	X
Spongomorpha arcta	—	—	X	X	X	X	X	—	—	—	—	—
Spongomorpha spinescens	—	—	—	—	X	X	X	—	—	—	—	—
Ulothrix flacca	X	X	Z	Z	X	X	—	—	—	—	X	X
Ulva lactuca	X	X	X	X	X	X	X	X	X	X	X	X
Urospora collabens	—	—	—	X	X	Z	—	—	—	—	—	—
Urospora penicilliformis	—	—	Z	Z	Z	X	X	X	—	—	—	—

TABLE II. SEASONAL OCCURRENCE AND REPRODUCTION OF SPECIES AT STATION 4

Rhodophyta

TAXON	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
Agardhiella tenera	—	—	—	—	—	X	X	C	C	C	—	—
Ahnfeltia plicata	M	M	M	X	M	—	X	X	—	X	X	M
Bonnemaisonia hamifera	—	—	—	—	—	—	—	—	—	—	X	X
Callithamnion roseum	—	—	—	—	—	—	X	X	T	T	—	—
Ceramium rubrum	X	X	T	T	X	X	T	X	X	—	X	X
Ceramium strictum	—	—	—	—	—	—	T	T	T	—	—	—
Champia parvula	—	—	—	—	—	—	—	T	T	—	—	—
Chrondrus crispus	C	C	X	C	C	C	X	X	C	C	C	C
Choreocolax polysiphoniae	X	X	—	X	—	—	—	—	X	X	—	—
Corallina officinalis	X	X	X	X	X	X	—	X	—	X	X	X
Cystoclonium purpureum var. *cirrhosum*	X	X	X	X	T,C	—	T	T,C	T	T,C	T,C	X
Dumontia incrassata	X	X	T	T	T	T	—	—	—	—	—	X
Goniotrichum alsidii	—	—	—	—	—	—	—	—	X	—	—	—
Grinnellia americana	—	—	—	—	—	—	—	T	T	T	—	—
Lomentaria orcadensis	—	—	—	—	—	—	—	—	T	T	X	X
Melobesia lejolisii	—	—	—	X	—	X	X	—	X	—	X	—
Phyllophora brodiaei	M	M	M	X	M	—	—	—	—	—	X	M
Phyllophora membranifolia	T	T	T	X	X	X	X	X	T	—	T	T
Polyides rotundus	T	T	T	—	X	—	X	—	X	—	T	T
Polysiphonia denudata	—	—	—	—	—	—	—	—	T,C	C	X	—
Polysiphonia elongata	X	—	X	—	—	—	—	—	T,C	T	X	X
Polysiphonia harveyi	—	—	—	—	—	—	X	T,C	T,C	C	X	—

TABLE II. — Rhodophyta (continued)

TAXON	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
Polysiphonia lanosa	X	X	—	X	X	—	—	T,C	T,C	T	T,C	X
Polysiphonia nigrescens	—	—	X	—	—	—	T	T	X	—	X	X
Polysiphonia novae-angliae	—	—	—	—	—	—	—	X	T,C	—	—	—
Polysiphonia urceolata	—	—	—	—	X	T	T,C	—	X	—	X	X
Porphyra leucosticta	—	—	—	—	—	—	—	—	—	—	X	X
Porphyra umbilicalis	—	—	X	X	X	—	—	—	—	—	—	—
Rhodemela confervoides	X	X	X	—	—	—	—	T	T	—	X	X
Rhodymenia palmata	T	T	T	T	T	T	X	T	T	T	T	X
Trailliella intricata	—	—	—	—	—	—	—	—	X	—	—	—

Phaeophyta

TAXON												
Ascophyllum nodosum	R	R	R	R	R	X	X	R	X	R	R	R
Asperococcus echinatus	—	X	X	US	—	—	—	X	—	—	—	X
Chorda filum	—	—	—	—	X	US	US	US	US	—	—	—
Chorda tomentosa	X	X	US	US	US	—	—	—	—	—	—	—
Chordaria flagelliformis	—	—	—	X	X	X	X	US	US	US	US	—
Desmarestia aculeata	X	X	X	X	X	X	X	—	X	X	X	—
Desmarestia viridis	—	—	—	X	X	X	X	—	—	—	—	—
Desmotrichum undulatum	—	—	—	US	—	—	—	—	—	—	—	—
Ectocarpus siliculosus	X	X	X	X	X	US	X	X	PS	PS	—	PS
Elachista fucicola	US	US	X	X	X	X	X	US	US	X	US	US
Fucus distichus ssp. *evanescens*	—	—	R	R	R	—	—	—	X	—	—	—

TABLE II. — Phaeophyta (continued)

TAXON	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
Fucus spiralis	R	R	R	X	R	X	X	—	R	R	X	X
Fucus vesiculosus	R	R	R	R	R	R	R	X	X	X	R	R
Giffordia granulosa	—	—	—	—	—	—	—	—	R	—	—	—
Laminaria digitata	—	—	—	X	—	—	—	—	—	—	—	—
Laminaria saccharina	US	US	US	US	X	X	X	X	X	X	US	X
Leathesia difformis	—	—	—	—	—	US	US	US	—	—	—	—
Myrionema strangulans	X	X	—	—	—	X	—	—	—	X	—	—
Petalonia fascia	PS	PS	X	X	PS	—	—	—	—	—	X	—
Pilayella littoralis	US	US,PS	US,PS	X	X	X	X	X	X	X	US	US
Ralfsia verrucosa	X	—	X	—	X	—	US	—	US	—	—	—
Scytosiphon lomentarius	PS	PS	PS	—	X	X	—	—	X	X	PS	PS
Sphacelaria cirrosa	X	P	P	X	P	X	X	X	—	X	P	P

Chlorophyta

TAXON												
Chaetomorpha linum	—	—	X	X	X	X	X	X	X	—	X	X
Chaetomorpha melagonium	—	—	—	—	—	X	X	X	—	—	—	—
Cladophora flexuosa	—	—	—	—	—	—	—	X	X	X	X	—
Codium fragile ssp. *tomentosoides*	—	—	—	G	G	G	G	G	G	G	G	—
Enteromorpha intestinalis	X	X	—	—	X	X	X	X	X	—	—	X
Ulva lactuca	X	X	X	X	X	X	X	X	X	X	X	X

TABLE III. SEASONAL OCCURRENCE AND REPRODUCTION OF SPECIES AT STATION 7

Rhodophyta

TAXON	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
Agardhiella tenera	—	—	X	X	X	C	C	T	C	T	X	X
Ahnfeltia plicata	M	M	M	M	M	X	X	M	—	—	M	M
Antithamnion americanum	—	—	X	T	T	—	—	—	—	—	—	—
Bangia fuscopurpurea	M	M	M	X	X	X	—	—	—	—	X	M
Callithamnion baileyi	—	—	—	—	T	T	T	X	X	—	—	—
Callithamnion roseum	C	—	—	—	X	X	X	—	—	S	X	—
Ceramium rubrum	X	X	X	T	X	T	X	T,C	T	T,C	X	T,C
Ceramium strictum	—	—	—	X	C	T	T	X	—	—	—	—
Champia parvula	—	—	—	—	—	T	T	T	T	X	T	X
Chondria sedifolia	—	—	—	—	—	X	T	X	X	X	X	X
Chondrus crispus	C	C	C	C	C	X	X	X	X	X	C	C
Corallina officinalis	X	X	X	X	X	X	X	X	X	X	X	X
Cystoclonium purpureum var. *cirrhosum*	—	X	X	T,C	T,C	X	X	X	X	X	—	X
Dasya pedicellata	—	—	—	—	—	—	T	T,C	C	T,C	X	X
Dermatolithon pustulatum	X	X	X	X	X	X	X	X	X	X	X	X
Gloiosiphonia capillaris	—	—	—	X	X	—	—	—	—	—	—	—
Goniotrichum alsidii	—	—	—	—	X	—	—	—	—	—	—	—
Grinnellia americana	—	—	—	—	—	X	T	T	T	X	—	—
Hildenbrandia prototypus	T	T	T	X	T	—	—	—	—	X	X	T
Hypnea musciformis	—	—	—	—	—	T	T	X	X	X	—	—
Lomentaria baileyana	—	—	—	—	X	X	T	X	—	—	—	—
Melobesia lejolisii	X	X	X	X	X	X	X	X	X	X	X	X

TABLE III. — Rhodophyta (continued)

TAXON	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
Phyllophora brodiaei	—	—	—	—	—	—	—	X	—	—	—	—
Phyllophora membranifolia	X	C	C	X	X	X	X	X	X	X	X	X
Polyides rotundus	—	—	X	X	X	X	—	—	—	—	—	X
Polysiphonia denudata	—	—	—	—	—	—	X	T	T	T	—	—
Polysiphonia harveyi	—	—	—	X	T	X	X	T,C	T	C	T,C	C
Polysiphonia lanosa	X	—	—	—	—	—	—	X	—	—	—	—
Polysiphonia nigrescens	—	—	X	—	X	T	X	X	X	T	T	X
Polysiphonia novae-angliae	—	—	T	—	—	X	—	—	X	T	—	—
Polysiphonia urceolata	C	—	C	X	T,C	X	T,C	T,C	C	X	—	X
Porphyra leucosticta	—	—	—	—	X	X	—	—	—	—	—	—
Porphyra miniata	—	X	X	—	—	—	—	—	—	—	—	—
Porphyra umbilicalis	—	—	—	—	X	X	a	X	a,b	X	a	X
Rhodomela confervoides	—	—	—	X	X	X	X	—	—	—	—	—
Rhodymenia palmata	—	—	X	X	X	X	X	—	—	—	—	—
Seirospora griffithsiana	—	—	—	—	—	X	X	X	—	—	—	—
Trailliella intricata	—	—	—	—	X	X	X	X	—	—	—	—

Phaeophyta

TAXON												
Ascophyllum nodosum	R	R	R	R	R	R	R	R	R	R	R	R
Asperococcus echinatus	—	US	US	X	US	X	X	X	—	—	—	X
Chorda filum	X	—	—	—	X	US	US	US	US	US	X	—
Chorda tomentosa	X	X	US	US	US	US	—	—	—	—	—	X
Chordaria flagelliformis	—	—	—	X	US	US	X	US	X	US	—	—

TABLE III. — Phaeophyta (continued)

TAXON	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
Desmarestia viridis	—	—	—	—	X	X	X	—	—	—	—	—
Desmotrichum balticum	—	—	US	—	—	—	—	US	—	—	—	—
Desmotrichum undulatum	—	—	US	US	US	X	X	X	X	—	—	—
Dictyosiphon foeniculaceus	X	X	X	X	X	X	X	X	X	X	—	—
Ectocarpus siliculosus	US,PS	X	X	US,PS	PS	PS	PS	X	X	PS	PS	PS
Elachista fucicola	X	X	X	X	US	US	US	US	X	US	US	X
Fucus spiralis	X	X	X	—	—	—	—	—	—	R	X	—
Fucus vesiculosus var. *sphaerocarpus*	R	X	R	R	R	X	X	R	R	R	R	R
Fucus vesiculosus var. *spiralis*	—	—	—	—	—	—	—	—	—	—	—	R
Giffordia granulosa	—	R	—	—	—	—	—	—	—	—	—	—
Giffordia secunda	—	—	—	—	X	—	PG	—	—	X	—	—
Laminaria saccharina	US	US	X	X	X	X	X	X	X	R	X	R
Leathesia difformis	—	—	—	X	US	US	US	—	—	—	—	—
Myrionema strangulans	—	—	X	X	X	—	—	X	—	X	—	—
Petalonia fascia	PS	PS	PS	X	PS	—	—	—	—	X	X	X
Punctaria latifolia	—	—	—	US	X	X	—	—	—	—	—	—
Punctaria plantaginea	—	—	X	US	X	US	X	X	—	—	—	—
Pilayella littoralis	US	US	US	US	US	X	X	X	X	X	X	US
Ralfsia fungiformis	—	X	X	—	—	—	—	—	—	—	—	X
Ralfsia verrucosa	—	X	X	X	X	X	US	US	X	X	—	—
Sargassum filipendula	X	X	R	X	R	X	R	R	R	R	X	X
Scytosiphon lomentarius	PS	PS	PS	PS	PS	PS	X	—	—	X	PS	PS
Sphacelaria cirrosa	X	X	P	P	P	P	P	X	P	P	P	X

TABLE III. — Phaeophyta (continued)

TAXON	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
Sphaerotrichia divaricata	—	—	—	—	—	X	X	US	US	US	—	—

Chlorophyta

TAXON												
Chaetomorpha linum	—	—	—	—	X	X	X	X	X	X	X	X
Chaetomorpha melagonium	—	—	—	X	—	—	—	—	—	—	—	—
Cladophora flexuosa	—	—	—	—	X	X	X	X	X	X	X	X
Cladophora gracilis	—	—	—	—	—	—	X	X	X	X	X	X
Codium fragile ssp. *tomentosoides*	X	G	G	G	G	G	G	G	G	G	G	G
Enteromorpha intestinalis	X	X	X	X	X	X	X	X	X	X	X	X
Enteromorpha linza	—	—	—	—	X	X	X	—	—	—	—	—
Monostroma grevillei	—	—	X	Z	Z	X	X	—	—	—	—	—
Monostroma pulchrum	—	X	X	Z	Z	X	—	—	—	—	—	—
Spongomorpha arcta	—	X	X	X	X	—	—	—	—	—	—	—
Ulothrix flacca	X	X	Z	Z	Z	X	—	—	—	—	—	—
Ulva lactuca	X	—	X	X	X	X	X	X	X	X	X	X
Urospora penicilliformis	X	X	Z	Z	Z	X	—	—	—	—	—	X

TABLE IV. LONGEVITY OF SPECIES

Chlorophyta

Taxon	Longevity
Chaetomorpha atrovirens Taylor	P
Chaetomorpha linum (Muller) Kützing	P
Chaetomorpha melagonium (Weber *et* Mohr) Kützing	P
Cladophora flexuosa (Muller) Harvey	P?
Cladophora gracilis (Griffiths *ex* Harvey) Kützing	P?
Codiolum gregarium A. Braun	A
Codiolum petrocelidis Kuckuck	A
Codium fragile (Sur.) Hariot ssp. *tomentosoides* (van Goor) Silva	P
Enteromorpha intestinalis (L.) Link	A
Enteromorpha linza (L.) J. Agardh	A
Monostroma grevillei (Thuret) Whittrock	A
Monostroma pulchrum Farlow	A
Rhizoclonium tortuosum Kützing	P
Spongomorpha arcta (Dillwyn) Kützing	A
Spongomorpha spinescens Kützing	A
Ulothrix flacca (Dillwyn) Thuret	A
Ulva lactuca L.	A
Urospora collabens (C. Agardh) Homes *et* Batters	A
Urospora penicilliformis (Roth) Areschoug	A

Phaeophyta

Taxon	Longevity
Ascophyllum nodosum (L.) Le Jolis	P
Asperococcus echinatus (Mertens) Greville	A
Chorda filum (L.) Stackhouse	A
Chorda tomentosa Lyngbye	A
Chordaria flagelliformis (Muller) C. Agardh	A
Desmarestia aculeata (L.) Lamouroux	P
Desmarestia viridis (Muller) Lamouroux	A
Desmotrichum balticum Kützing	A
Desmotrichum undulatum (J. Agardh) Reinke	A
Dictyosiphon foeniculaceus (Hudson) Greville	P
Ectocarpus siliculosus (Dillwyn) Lyngbye	A
Elachista fucicola (Velley) Areschoug	P
Fucus distichus L. emend. ssp. *distichus* (C. Agardh) Powell	P
Fucus distichus L. emend. ssp. *edentatus* (C. Agardh) Powell	P
Fucus distichus L. emend. ssp. *evanescens* (C. Agardh) Powell	P

Phaeophyta

Taxon	Longevity
Fucus spiralis L.	P
Fucus vesiculosus L.	P
Fucus vesiculosus var. *sphaerocarpus* J. Agardh	P
Fucus vesiculosus var. *spiralis* Farlow	P
Giffordia granulosa (Smith) Hamel	A
Giffordia secunda (Kützing) Batters	A
Laminaria digitata (Hudson) Lamouroux	P
Laminaria saccharina (L.) Lamouroux	P
Leathesia difformis (L.) Areschoug	A
Myrionema strangulans Greville	P?
Petalonia fascia (Muller) Kuntze	A
Pilayella littoralis (L.) Kjellman	P
Punctaria latifolia Greville	A
Punctaria plantaginea (Roth) Greville	A
Ralfsia fungiformis (Gunner) Setchell *et* Gardner	P
Ralfsia verrucosa (Areschoug) J. Agardh	P
Sargassum filipendula C. Agardh	P
Scytosiphon lomentarius (Lyngbye) Link	A
Sphacelaria cirrosa (Roth) C. Agardh	P
Sphaerotrichia divaricata (C. Agardh) Kylin	A

Rhodophyceae

Taxon	Longevity
Agardhiella tenera (J. Agardh) Schmitz	A?
Ahnfeltia plicata (Hudson) Fries	P
Antithamnion americanum (Harvey) Farlow	A
Bangia fuscopurpurea (Dillwyn) Lyngbye	A
Bonnemaisonia hamifera Hariot	P
Callithamnion baileyi Harvey	P?
Callithamnion roseum (Roth) Lyngbye	A?
Ceramium rubrum (Hudson) C. Agardh	P
Ceramium strictum Harvey	A
Champia parvula (C. Agardh) Harvey	A
Chondria sedifolia Harvey	A
Chondrus crispus Stackhouse	P
Choreocolax polysiphoniae Reinsch.	P
Clathromorphum circumscriptum (Strømfelt) Foslie	P
Corallina officinalis L.	P
Cystoclonium purpureum (Hudson) Batters var. *cirrhosum* Harvey	P

Rhodophyceae (Continued)

Taxon	Longevity
Dasya pedicellata (C. Agardh) C. Agardh	A
Dermatolithon pustulatum (Lamouroux) Foslie	P
Dumontia incrassata (Muller) Lamouroux	A
Gigartina stellata (Stackhouse) Batters	P
Gloiosiphonia capillaris (Hudson) Carmichael *ex* Berkeley	A
Goniotrichum alsidii (Zanardini) Howe	A
Griffithsia tenuis C. Agardh	A
Grinnellia americana (C. Agardh) Harvey	A
Hildenbrandia prototypus Nardo	P
Hypea musciformis (Wulfen) Lamouroux	A
Lithophyllum corallinae (Crouan) Heydrich	P
Lithothamnium glaciale Kjellman	P
Lomentaria baileyana (Harvey) Farlow	A
Lomentaria orcadensis (Harvey) Collins *ex* Taylor	P?
Melobesia lejolisii Rosanoff	P
Petrocelis middendorfii (Ruprecht) Kjellman	P
Phyllophora brodiaei (Turner) Endlick	P
Phyllophora membranifolia (Goodenough *ex* Woodward) J. Agardh	P
Phymatolithon lenormandi (Areschoug) Adey	P
Plumaria elegans (Bonnemaison) Schmitz	P
Polyides rotundus (Hudson) Greville	P
Polysiphonia denudata (Dillwyn) Greville *ex* Harvey in Hooker	A
Polysiphonia elongata (Hudson) Sprengel	P
Polysiphonia harveyi Bailey	A
Polysiphonia lanosa (L.) Tandy	P
Polysiphonia nigrescens (Hudson) Greville	P
Polysiphonia novae-angliae Taylor	P
Polysiphonia urceolata (Lightfoot *ex* Dillwyn) Greville	P
Porphyra leucosticta Thuret	A
Porphyra miniata (C. Agardh) C. Agardh	A
Porphyra umbilicalis (L.) J. Agardh	A
Rhodochorton penicilliforme (Lightfoot) Rosenvinge	P
Rhodomela confervoides (Hudson) Silva	P
Rhodymenia palmata (L.) Greville	P
Seirospora griffithsiana (Harvey) Dixon	A
Trailliella intricata (J. Agardh) Batters	P

TABLE V. DOMINANT ANNUALS NORTH AND SOUTH OF THE CANAL

ANNUALS	
NORTH	SOUTH
Bangia fuscopurpurea	*Agardhiella tenera*
Dumontia incrassata	*Antithamnion americanum*
Lomentaria baileyana	*Bangia fuscopurpurea*
Polysiphonia harveyi	*Callithamnion roseum*
Porphyra umbilicalis	*Ceramium strictum*
	Champia parvula
	Chondria sedifolia
	Dasya pedicellata
	Dumontia incrassata
	Grinnellia americana
	Hypnea musciformis
	Lomentaria baileyana
	Polysiphonia harveyi
	Porphyra umbilicalis
	Seirospora griffithsiana
	Trailliella intricata
Asperococcus echinatus	*Asperococcus echinatus*
Chorda filum	*Chorda filum*
Chorda tomentosa	*Chorda tomentosa*
Chordaria flagelliformis	*Chordaria flagelliformis*
Ectocarpus confervoides	*Desmotrichum undulatum*
Leathesia difformis	*Ectocarpus confervoides*
Petalonia fascia	*Leathesia difformis*
Scytosiphon lomentaria	*Petalonia fascia*
	Punctaria latifolia
	Punctaria plantaginea
	Scytosiphon lomentaria
	Sphaerotrichia divaricata
Codiolum petrocelidis	*Enteromorpha intestinalis*
Enteromorpha intestinalis	*Monostroma grevillei*
Monostroma grevillei	*Monostroma pulchrum*
Monostroma pulchrum	*Spongomorpha arcta*
Spongomorpha arcta	*Ulothrix flacca*
Spongomorpha spinescens	*Urospora penicilliformis*
Ulothrix flacca	
Ulva lactuca	
Urospora collabens	
Urospora penicilliformis	

TABLE VI. DOMINANT PERENNIALS NORTH AND SOUTH OF THE CANAL

PERENNIALS	
NORTH	SOUTH
Ahnfeltia plicata	*Callithamnion baileyi*
Ceramium rubrum	*Ceramium rubrum*
Chondrus crispus	*Chondrus crispus*
Choreocolax polysiphoniae	*Corallina officinalis*
Clathromorphum circumscriptum	*Cystoclonium purpureum* var. *cirrhosum*
Corallina officinalis	*Fosliella lejolisii*
Cystoclonium purpureum var. *cirrhosum*	*Lithophyllum macrocarpum*
Gigartina stellata	*Phyllophora membranifolia*
Hildenbrandia prototypus	*Polysiphonia nigrescens*
Lithophyllum corallinae	*Polysiphonia urceolata*
Lithophyllum macrocarpum	
Petrocelis middendorfii	
Phyllophora membranifolia	
Phymatolithon lenormandi	
Plumaria elegans	
Polyides carpinus	
Polysiphonia lanosa	
Polysiphonia nigrescens	
Polysiphonia urceolata	
Rhodochorton penicilliforme	
Rhodomela confervoides	
Rhodymenia palmata	
Ascophyllum nodosum	*Ascophyllum nodosum*
Desmarestia aculeata	*Dictyosiphon foeniculaceus*
Elachista fucicola	*Elachista fucicola*
Fucus distichus ssp. *distichus*	*Fucus vesiculosus* var. *sphaerocarpus*
Fucus distichus ssp. *edentatus*	*Pilaiella littoralis*
Fucus spiralis	*Sargassum filipendula*
Fucus vesiculosus	*Sphacelaria cirrosa*
Laminaria digitata	
Laminaria saccharina	
Pilaiella littoralis	
Ralfsia fungiformis	
Ralfsia verrucosa	
Sphacelaria cirrosa	
Chaetomorpha atrovirens	*Chaetomorpha linum*
Chaetomorpha linum	*Cladophora flexuosa*
Chaetomorpha melagonium	*Cladophora gracilis*
Rhizoclonium tortosum	*Codium fragile* ssp. *tomentosoides*

TABLE VII. PATTERNS OF SEASONAL OCCURRENCE OF ANNUALS

ANNUALS OCCURRING EARLIER SOUTH THAN NORTH OF CAPE

Agardhiella tenera
Ceramium strictum
Gloiosiphonia capillaris
Lomentaria baileyana
Polysiphonia denudata
Polysiphonia harveyi
Porphyra miniata
Chorda filum
Desmotrichum balticum
Ectocarpus siliculosus
Leathesia difformis
Punctaria latifolia
Monostroma pulchrum
Urospora penicilliformis
Monostroma grevillei

ANNUALS DISAPPEARING EARLIER SOUTH THAN NORTH

Bangia fuscopurpurea
Ceramium strictum
Dumontia incrassata
Gloiosiphonia capillaris
Lomentaria baileyana
Porphyra miniata
Porphyra umbilicalis
Chorda tomentosa
Chordaria flagelliformis
Desmarestia viridis
Leathesia difformis
Petalonia fascia
Scytosiphon lomentarius
Urospora penicilliformis

ANNUALS FOUND ALL YEAR ON BOTH SIDES

Asperococcus echinatus
Scytosiphon lomentarius
Enteromorpha intestinalis
Ulva lactuca

TABLE VIII. PATTERNS OF REPRODUCTIVE PERIODICITIES OF ANNUALS

ANNUALS REPRODUCING EARLIER SOUTH THAN NORTH

Agardhiella tenera
Ceramium strictum
Dumontia incrassata
Lomentaria baileyana
Polysiphonia harveyi

Asperococcus echinatus
Chorda filum
Chorda tomentosa
Chordaria flagelliformis
Desmothrichum balticum
Ectocarpus siliculosus
Elachista fucicola
Lethesia difformis

ANNUALS TERMINATING REPRODUCTION EARLIER SOUTH THAN NORTH

Bangia fuscopurpurea
Dumontia incrassata
Lomentaria baileyana
Porphyra umbilicalis

Asperococcus echinatus
Leathesia difformis
Petalonia fascia

Monostroma grevillei

ANNUALS REPRODUCING THROUGHOUT THE YEAR NORTH OF THE CAPE WITH LIMITED REPRODUCTIVE PERIODS SOUTH OF THE CAPE

Porphyra umbilicalis

Petalonia fascia
Scytosiphon lomentarius

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A LIST OF THE MONOCOTYLEDONEAE OF BELIZE INCLUDING A HISTORICAL INTRODUCTION TO PLANT COLLECTING IN BELIZE

DAVID L. SPELLMAN, JOHN D. DWYER,
AND GERRIT DAVIDSE

The country of Belize, formerly British Honduras, which has had internal self-government since 1964, lies south of the Yucatan Peninsula about 800 miles south of New Orleans, Louisiana. The country is bounded on the north by Mexico's Territory of Quintana Roo, on the west and south by Guatemala, and on the east by the Caribbean Sea. In length, the country extends from the Rio Hondo in the north to the Sarstoon River in the south, a distance of 174 miles. At its widest point, it is 70 miles from Belize City on the sea to the western border. In area Belize is approximately the size of the State of Massachusetts. The country encompasses 8,750 square miles exclusive of 116 square miles of offshore islands known locally as cays. It is divided into the following political districts: Belize, Cayo, Corozal, Orange Walk, Stann Creek, and Toledo (Fig. 1).

Belize is almost bisected by the Belize River. The northern half of the country is similar to the southern part of the Yucatan Peninsula, being a fairly level plain with a maximum elevation of about 120 m. above sea level. The southern part of the country is mountainous for the most part. The dominant physiographic features in the south are the Maya and Cockscomb Mountains. The reader is referred to a recent paper (Kessler *et al.*, 1974) dealing with the geological history of this area. Average elevations in both these mountain masses lie between 850 m. and 910 m. above sea level, with the country's highest point reaching over 1130 m.

Climatically the country is described as sub-tropical even though under the Koeppen classification it is classified as "Am" (tropical monsoon) north of the Maya Mountains

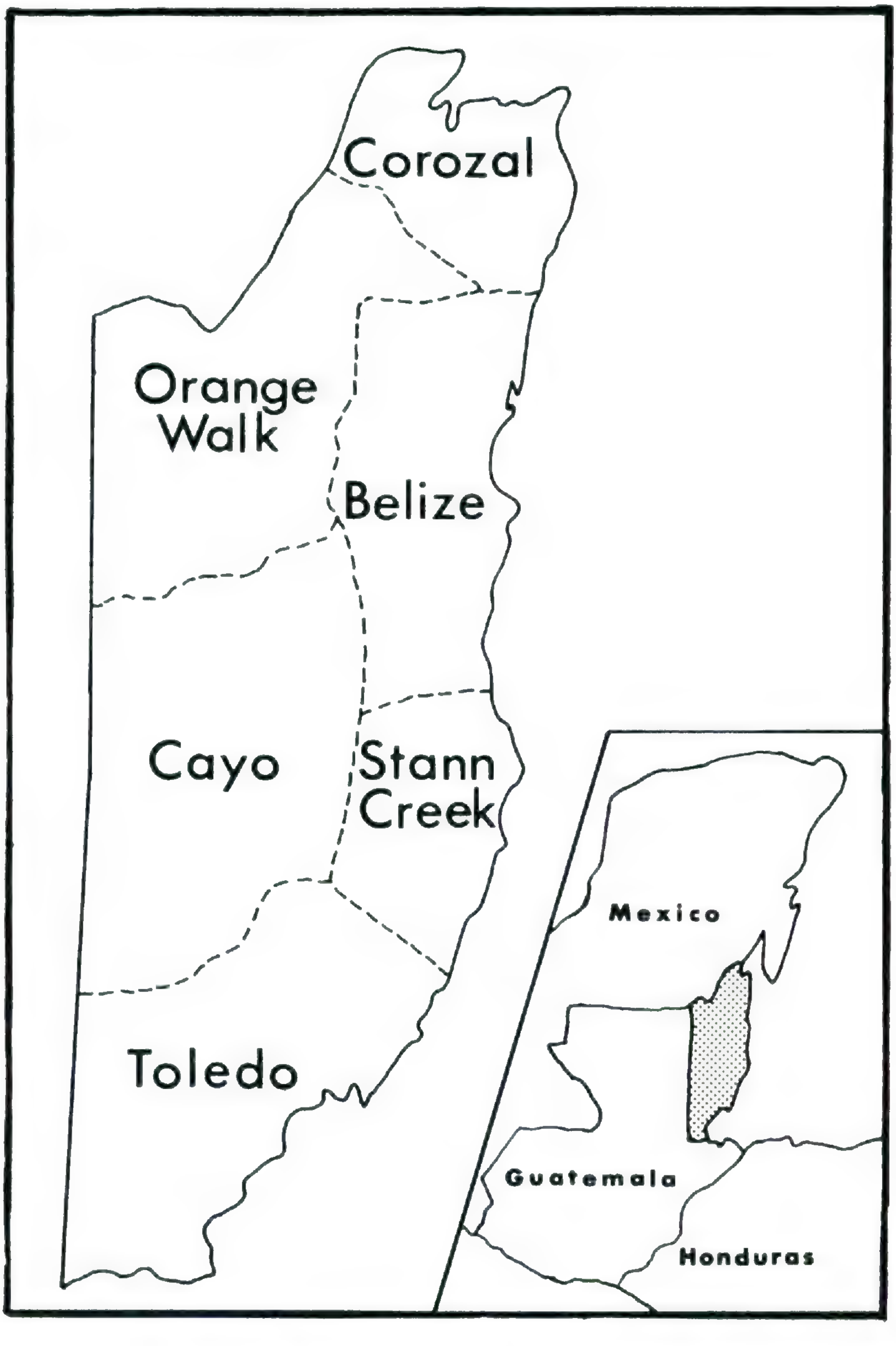

Figure 1. Map of Belize showing administrative districts, and relationship to neighboring countries (inset).

and "Af" (tropical rainforest) in the mountainous south. There is a marked dry season from February to May. Precipitation is greatest in the south and in the central mountain mass, and decreases to the north. Average annual precipitation ranges from 432 cm. in the Toledo District in the south to 132 cm. in the Corozal District in the north.

According to Lundell (1945), in terms of area Belize has a floral diversity which is perhaps unequaled among the countries of Middle America. Standley & Record (1936) state that the most significant element of the flora is West Indian. There are a large number of plants native to Cuba, Jamaica, and other parts of the West Indies, which on the continent are known only from Belize. This provides students of plant geography with a unique opportunity for investigation. Pine stands, swamps, and marshes occur in the northern plain. In the south the vegetation approaches rainforest in composition, and resembles in some respects forests in adjacent Guatemala with an admixture of Panamanian and South American elements.

Sprague & Riley (1924) predicted a flora of about 4000 species for the country, an estimate with which Lundell (1945) concurred. Standley & Record (1936) regarded endemism as low, citing a total of 138 species which could be so designated. If this be the rate of endemism, it will be about four percent. This is strikingly low, considering that Lundell estimated about fifteen percent for the entire Yucatan Peninsula.

Sprague's statement in 1924 that the flora of Belize was perhaps less known than that of any other British Colony still holds true today. Prior to 1883, there were probably not more than twenty sheets of dried plants in the Kew Herbarium (Sprague & Riley, 1924). During the period 1883 to 1894, this number was increased by about 200 through the efforts of Daniel Morris, E. D. M. Hooper, J. Robertson, and Sir Alfred Maloney, the then Governor of the Colony.

The first collection of any significant size was that of Morton E. Peck of the Yale University School of Forestry.

Professor Peck visited the country during the years 1905 to 1907, collecting about 1000 numbers. No complete account of the Peck collections has ever been published, but partial accounts have been given of the grasses by Hubbard (1913) and of the Dicotyledoneae by Blake (1917) and Sprague & Riley (1924). The Peck collections include more than 50 type specimens.

Following Peck's visit to the country, virtually no botanizing occurred for two decades. A resurgence of activity took place in 1926, however, when a cooperative study was initiated by the Forestry Department of the country and the Yale School of Forestry, chiefly through the efforts of Samuel J. Record and his colleagues at Yale University. This led to collections by several of the University personnel as well as by various members of the local Forestry Department and employees of private timber companies.

In 1928 and 1929 C. L. Lundell collected approximately 700 numbers at Honey Camp in the Orange Walk District, under the auspices of the Tropical Research Foundation. In 1929, the significant collections of W. A. Schipp were started in Stann Creek and Toledo Districts. Schipp's botanical activities in Belize were discussed at length by R. M. Lowden (1970). It appears that Schipp's sole means of support was obtained through the sale of herbarium and seed collections. His *Flora of British Honduras* for 1933-1934 is a collector's item; it is a mimeographed catalogue listing some 1129 flowering plants and offering for sale seeds and preserved plant parts. His collections from 1929 to 1941 contain at least 3500 numbers.

The period 1931 to 1958 is noteworthy for the quantity of plants collected in Belize as well as their quality. During the Maya Expeditions of the Carnegie Institution and the University of Michigan, H. H. Bartlett and C. L. Lundell botanized extensively in Cayo District and made smaller collections in Belize District (Lundell, 1940). Lundell's collections of 1928 through 1936 amount to about 3000 numbers.

During the Maya Expedition of 1931, Bartlett trained Percy Gentle of Belize City as a botanical collector (Bartlett, 1935). Lundell later assumed the responsibility of directing Gentle's field activities. Gentle remained an active collector until shortly before his death in 1958. His collection represents the largest by a single individual, just under 10,000 numbers being gathered between 1931 and 1958 (Lundell, 1960).

The Cambridge University Expedition of 1959 and 1960 accounts for two significant sets of collections. The first of these was a series of more than 700 numbers collected by the Expedition botanist D. R. Hunt. Hunt's collections are from Toledo, Stann Creek, and Cayo Districts. Most of his numbers seem to be from the Mountain Pine Ridge area of Cayo District. The second collection was made by the geographer of the Expedition, D. R. Stoddart. Stoddart's collecting activities were in conjunction with his mapping of certain of the cays. While his collections were not as extensive as those of Hunt, they are important, since they represent the only extensive collections from the offshore islands. Subsequent visits by Stoddart, with F. R. Fosberg, and M.-H. Sachet and D. Spellman, have yielded rather complete collections from 65 of the cays.

From 1961 to 1969 several botanists visited the country; these include George Proctor of the Institute of Jamaica, John Dwyer of St. Louis University and the Missouri Botanical Garden, Thomas Elias, then a graduate student at Southern Illinois University (Carbondale), Martin Kellman of Simon Fraser University, and Edward Tyson and his students from Florida State University.

The year 1970 yielded two sets of collections. The senior author collected about 800 numbers in January and in July while working with the University of Edinburgh Expedition to British Honduras (Furley, 1972). Sidney McDaniel of Mississippi State University made extensive collections in March.

From 1972 to the present time the bulk of plant collecting in Belize has been done by botanists from the Missouri

Botanical Garden. Thomas Croat, Curator of Phanerogams, collected 1794 numbers in 21 field days in the period from the 23rd of May to June 19, 1973. Alwyn Gentry, Assistant Curator at the Garden, collected about 1000 numbers during the same time. John Dwyer, Research Associate at the Garden, made several trips to Belize since 1972, collecting about 2750 numbers, almost 1000 numbers being gathered at the same time and in the same localities visited by Croat and Gentry. In eleven days in the field in January, 1974, Dwyer returned to Belize to collect about 450 numbers in the central and northern sections of the country. In ten days of field work in January, 1974, Liesner collected 293 numbers in the Districts of Belize, Cayo, and Orange Walk. By arrangement with the Belize Government, representative collections from the Croat, Dwyer, Gentry, and Liesner lots are being selected and forwarded from the Garden for permanent deposit in the recently established herbarium at Belmopan, the new capital of Belize.

The following are other botanists who over the past four years have done some collecting in Belize:

Dr. Derek Burch, University of South Florida
Dr. William Crankshaw, Ball State University
Father Leonard Dieckman, S.J., St. Johns College, Belize City
Dr. Richard Keating, Southern Illinois University (Edwardsville)
Dr. Yon Linhart, University of Colorado
Dr. Robert Long, University of South Florida
Dr. Richard Pippen, Western Michigan University
Dr. Paul Sorenson, Northern Illinois University
Dr. Mario Sousa, The National University of Mexico
Mr. Bruce Vanderveen, graduate student, St. Louis University
Dr. Richard Wunderlin, University of South Florida.

The following list includes most of the botanists who collected in Belize during the past century or more and the year or years in which they collected:

Aguilar, Mercedes
Aitken, J. B. — 1927
Anderson, Roger — 1970
Bartlett, H. H. — 1931
Brown, C. S. — 1927-1929?
Brunt, Martin
Burns, J. A.
Campbell, A. J. F. — 1922
Carrick, J.
Castillo, A. — 1932
Chanek, M.
Contreras, Elias — 1968
Crankshaw, William — 1970
Croat, Thomas — 1973
Day, David Fisher — 1864
Dieckman, Rev. L. — 1970-1972
Donald, G. H.
Dwyer, John — 1967; 1972-1974
Egler, F. E. — 1942
Elias, Thomas — 1967
Fralish, James — 1970
Gentle, Percy H. — 1931-1958
Heyder, H. M. — 1927
Hooper, E. D. M.
Hope, M. O.
Hummel, C.
Hunt, D. R. — 1959-1960
Karling, J. S. — 1927-1928
Keating, Richard — 1971-1972
Kellerman, W. A. — 1906-1907
Kellman, M. C. — 1969
Kinloch, J. B. — 1932-1933
Kluge, H. C. — 1924?
Lamb, A. F. A. — 1947?
Lancaster, probably Thomas Leonard, a New Zealander
Lazor, Robert — 1970
Liesner, Ron — 1974
Long, Robert — 1970

Lundell, C. L. — 1928-1929
McDaniel, Sidney — 1972
Maxwell, Richard — 1967
Meyer, William C. — 1930
Molino, Antonio — 1954
Maloney, Sir Alfred — 1893-1894
Morris, Sir Daniel — 1893-1894
Newey, Walter W. — 1970
O'Neil, Rev. Hugh — 1936
Peck, M. E. — 1905-1907
Pelly, R. S. — 1933
Pippen, R. — 1972-1973
Proctor, G. R. — 1969
Record, S. J. — 1926; 1930
Robertson, Rev. J. — 1883-1884
Rose-Innes, R. — 1970
Sachet, M.-H. — 1972.
Sampson, H. C. — 1928
Schipp, William A. — 1929-1938
Schmidt, K. P. — 1923
Smart, H. P. — 1920; 1930?
Sorenson, Paul — 1972
Sousa, M. — 1973
Spellman, D. L. — 1970-1972
Stanton, Rev. W. A., S.J. — 1896; ca. 1906
Stevenson, Duncan — 1927-1928
Stevenson, Neil S. — 1927-1928
Stocker, C. L. — 1924
Stoddart, D. R. — 1959-1972
Thompson, J. E. — 1927-1929; 1931
Tyson, Edward — 1970
Vaughn, Joseph — 1971
Vanderveen, B. — 1973
Winzerling, H. W. — 1926-1927
Wunderlin, Richard — 1971

We have been unable to determine the given names of the following collectors: Mrs. Armstrong; Disney; Einth; Espat; and Saunders.

LIST OF THE MONOCOTYLEDONEAE

The flora of Belize has been treated in part or in a comprehensive fashion in a number of publications. Schipp's (1933-1934) *Flora of British Honduras, Price List of Seeds & Herbarium Material* was the first attempt to list all of the vascular plants from the country. This was followed by the checklist of Standley & Record entitled *The Forests and Flora of British Honduras*, which is considerably more complete. As a result of the Maya Expeditions in the 1930's, Lundell and other contributors published detailed taxonomic papers on several plant families or parts thereof. These appeared in two volumes entitled *Botany of the Maya Area* (Publ. Carnegie Inst. Wash., 1936, 1940). These treatments, although wider in geographical coverage than Belize, are a valuable source of information for the flora of Belize. Since 1946 the *Flora of Guatemala*, now nearing completion, has attempted to include the plants of Belize as well as those of Guatemala and currently represents the most authoritative source of information for the flora of Belize.

The following list of Monocotyledoneae is presented as a way of updating current knowledge of this part of the Belize flora. The list was prepared by searching the literature, by examining collections in herbaria, by identifying recently collected materials, and by checking field notes and unpublished lists. Any novelties encountered in studying very recent collections will be described and published separately by specialists. Virtually all collections made recently by botanists from the Missouri Botanical Garden are deposited in the herbarium of the Garden (MO).

We have attempted to cite individually most of the collections made in Belize since 1959, especially the extensive ones made by the staff of the Missouri Botanical Garden in the last few years. Since many of the collections made before 1959 have been treated in the *Botany of the Maya Area* or formed a basis for the treatments in the *Flora of Guatemala*, as well as in monographs and other taxonomic papers, we have not cited these specimens specifically. We have

examined all collections cited in this paper with the exception of those of D. R. Hunt.

The names of the collectors encountered in the list are abbreviated as follows:

C = Thomas Croat
D = John Dwyer
Dieck = Leonard Dieckman
G = Alwyn Gentry
H = D. R. Hunt
K = Martin Kellman
Lies = Ron Liesner
Lin = Yon Linhart
Lon = Robert Long
P = George Proctor
Sor = Paul Sorenson
Sp = Spellman
V = Bruce Vanderveen
D & L = Dwyer and Liesner
D & P = Dwyer and Pippen
DEM = Dwyer, Elias and Maxwell
L & D = Liesner and Dwyer
Sp & St = Spellman and D. R. Stoddart*

*All collections by Spellman and Stoddart, cited as Sp & St, are from the cays.

The authors of this paper would like to express their thanks to the Belize Government, especially to the Premier, the Hon. George Price, for his sustained interest in the project, as well as to Mr. E. O. Bradley, Acting Chief Forest Officer, for his assistance. The extensive collecting done by the botanists of the Missouri Botanical Garden in 1973-1974 has been facilitated greatly by the physical facilities provided at Ridge Lagoon Plantation, located at Mile 11½ on the Northern Highway, Belize by Robert Baumgartner, an American residing in Belize. The assistance rendered by the faculty at St. Johns College, Belize City is gratefully acknowledged. The senior author derived valuable field experience from his association with the Univer-

sity of Edinburgh Expedition to Belize in July-August 1970 under the direction of Dr. Peter Furley. He was also fortunate in having botanized the Cays of Belize with Dr. Raymond Fosberg and Dr. David Stoddart during June-July, 1972. Father Leonard Dieckman, S.J., and Mrs. Lydia Waight of Belize City were kind enough to check the historical introduction. Special thanks are due to Dr. Thomas Croat for his assistance in identifying the Araceae and Bromeliaceae. Special thanks are due the National Geographic Society for financial support given to Dr. Dwyer during the years 1973 and 1974 as well as the support received from the Associated Universities for International Education.

In the list, those species which we judge have not been previously recorded from Belize in published accounts, are marked by an asterisk before the binomial.

Alismataceae

Echinodorus andrieuxii (H. & A.) Small — P 29929
E. grandiflorus (Cham. & Schlecht.) Micheli — D 10978
E. nymphaeafolius (Griseb.) Buch.
Sagittaria lancifolia L.

Amaryllidaceae

Bomarea edulis (Tuss.) Herb. — P 29659
Crinum erubescens Ait.
Curculigo scorzonerifolia (Lam.) Baker — H 22
**Furcraea guatemalensis* Trel. — Sor 7052
Hippeastrum puniceum (Lam.) Urban — Lin 205
Hymenocallis cf. *caribaea* Herb. — Sp 1787; Sp 1843
H. littoralis (Jacq.) Salisb. — P 29938; Sp & St 2268; Sp & St 2288; Sp & St 2360; Sp & St 2449; Sp & St 2478
Zephyranthes lindleyana Herb.

Araceae

Anthurium sp. — G 7833
A. aemulum Schott — D 9859; D 11560; D & L 12343; G 8025; Sp 1604
A. bakeri Hook. f. — C 24225; C 24453

A. concinnatum Schott
A. crassinervium (Jacq.) Schott — L & D 1472
A. denudatum Engler — C 23533
A. gracile (Rudhe) Lindley — G 7954; V 616; V 618; V 621
A. scandens (Aubl.) Engler — C 23592; C 24309; D 12690; G 7912; D 9946; P 30356
A. scolopendrinum (Hamilt.) Kunth
A. tetragonum Hook. ex Schott. — Sp 1948; V 658
A. trinerve Miq. — G 7413
A. verapazense Engl. — P 29825
Dieffenbachia aurantiaca Engl. — D 11184
D. sequina (L.) Schott
Monstera acuminata Koch
M. adansonii Schott — G 7434
M. belizensis Lundell
M. magnispatha Matuda
M. tuberculata Lundell
Montrichardia arborescens (L.) Schott — L & D 1448; L & D 1644
Philodendron belizense Standl.
P. brevispathum Schott — G 8423
P. fragrantissimum (Hook.) Kunth — C 24510
P. guttiferum Kunth — D 11306; G 8018; G 8241; P 29700
P. hederaceum (Jacq.) Schott — Sp 1967
P. inequilaterum Liebm. — C 24305; D 11103
P. panamense Krause — D 9891; G 8033; G 8132
P. radiatum Schott — C 23534; C 24335; C 24512
P. scandens C. Koch & Cello — C 23697; C 24511; D 12718
P. tripartitum (Jacq.) Schott — C 23670; C 24509
Pistia stratiotes L. — D & L 12158
Rhodospatha acuminata C. Koch
R. nervosa Lundell
Spathiphyllum blandum Schott — G 8017; G 8147; G 8255
S. friederichsthali Schott — C 24332; C 24451A
S. phryniifolium Schott

Syngonium podophyllum Schott — D & L 12043; G 8133; L & D 1468; P 29596; P 29916; Sp 1584
Xanthosoma violaceum Schott — D & L 12078; P 29941

Bromeliaceae

Aechmea bracteata (Sw.) Mez — C 23922; C 23950; C 24686; D 10116; D & L 12035; D & L 12184; P 30238
A. bromeliaefolia (Rudge) Baker
A. dactylina Baker — G 6791
A. mexicana Baker — D & L 12129
A. nudicaulis L. Griseb.
A. tillandsioides (Hart.) Baker — C 24678; P 30178; V 607
Ananas comosus (L.) Merr.
Androlepis donnell-smithii (Baker) Mez — C 23322; C 24314
Billbergia viridiflora Wendl.
Catopsis aloides (Cham. & Schlecht.) Baker
C. berteroniana (Schult.) Mez — P 29818
C. morreniana Mez — Sp 1988; Sp 2002
C. sessiliflora (R. & P.) Mez var. *dioica* L. B. Sm.
Guzmania lingulata (L.) Mez — C 23768; D 9934
Pitcairnia imbricata (Brong.) Regel
P. hemsleyana Mez
P. aff. *integrifolia* Gawl — C 23848
P. petiolata (Koch & Bouche) Baker — P 29439
Tillandsia balbisiana Schult. — D & L 12199; P 29529; P 29598
T. bulbosa Hook. — C 24041; C 24803; D & L 12187A; D & L 12362; G 7974; P 29645
T. dasyliriifolia Baker — C 23274; DEM 623; H 612
T. digitata Mez
T. excelsa Griseb.
T. fasciculata Sw. — D & L 12167; Sp 1981
T. festucoides Brong. ex Mez — C 23607; G 7788; P 30223
T. filicifolia Cham. & Schlecht.
T. juncea (R. & P.) Poir. — G 7961
T. leiboldiana Schlecht.

T. monadelpha (E. Morren) Baker — G 7974
T. polystachia L.
T. schiedeana Steud. — C 23760; C 24327; D 9847
T. streptophylla Scheidw. — C 23881 A; D & L 12186; D & L 12365; L & D 1600; P 29528
T. sublaxa Baker
T. utriculata L.
T. valenzuelana A. Rich. — C 23766; C 23758
T. vestita Schlecht. & Cham.
Vriesa disticha (L.) Small
V. paniculata (L.) Mez
V. schippii L. B. Sm.

Burmanniaceae
Apteria aphylla (Nutt.) Barnh. ex Small
Burmannia capitata (Walt.) Mart. — D & L 12369; P 29684
B. flava Mart.
Dictyostegia campanulata Karst.
D. orobanchioides (Hook.) Miers
Gymnosiphon tenellus (Benth.) Urban

Cannaceae
Canna edulis Ker — K 451; P 29465
C. indica L. — DEM 141; Sp 1411

Commelinaceae
Callisia repens L.
C. ciliata H.B.K.
Campelia zanonia (L.) H.B.K. — D 9854; D 9883
Commelina diffusa Burm.f. — K 411
C. elegans H.B.K.
C. erecta L. — C 23801; C 24100; G 8003
C. longicaulis Jacq.
Dichorisandra hexandra (Aubl.) Standl.
Phaeosphaerion persicariaefolium (DC.) C. B. Clarke
Rhoeo spathacea (Sw.) Stearn — P 29646; Sp 1977; Sp 1980; Sp 1987; Sp 2007
Tradescantia belizensis Standl.

T. geniculatum Jacq. — P 30078
T. lundellii Standl.
Tripogandra cumanensis (Kunth) Woodson — P 30153
T. grandiflora (D. Sm.) Woodson — H 399; K 592; P 29692; Sp 2008
T. serrulata (Vahl) Handlos — C 23717; G 7981
Zebrina pendula Schnizl.

Cyclanthaceae
Asplundia chiapensis (Mart.) Harl.
Carludovica palmata R. & P.
C. utilis (Oerst.) Benth. & Hook.

Cyperaceae
**Abildgaardia ovata* (Burm.f.) Kral — D 11050
Bulbostylis arenaria (Nees) Lindm. — H 189; P 29431
B. capillaris (L.) C.B. Clarke
B. junciformis (H.B.K.) Lindm. — H sn; H 13; H 244
B. paradoxa (Spreng.) Lindm. — D & P 10124; H 81; P 29432
B. tenuifolia (Rudge) Macbr. — C 23962
B. vestita (Kunth) C.B. Clarke — D 11608; H 18
Calyptrocarya glomerulata (Brong.) Urban — G 8595
Carex polystachya Sw. ex Vahl var. *bartletti* (O'Neill) Standl. & Steyermark — H 248; P 29647
Cladium jamaicense Crantz — C 23296; C 24995; D 12642; DEM 629; Dieck 294; G 8527; Sp & St 2239
Cyperus articulatus L.
C. brevifolius (Rottb.) Endl. ex Hassk.
C. compressus L.
C. cyperoides (L.) Kuntze — H 283
C. diffusus Vahl — C 24865; G 7997; G 8032; G 8443
C. digitatus Roxb. — P 29926
C. eggersii Boeck.
C. elegans L.
C. esculentus L.
C. flavus (Vahl) Nees
C. haspan L. — C 23915; C 23998; C 24865; D 10756; H 100; P 29675; P 29716

C. hermaphroditus (Jacq.) Standl. — C 24853
C. humilis Kunth — P 29580
C. imbricatus Retz.
C. ischnos Schlecht.
C. lanceolatus Poir.
C. lentiginosus Millsp. & Chase
C. ligularis L. — C 24066; C 24106; C 24533; DEM 516; Lin 30; Sp & St 2211; Sp 2450
C. luzulae (L.) Retz. — C 23522; C 23800; D 12705; DEM 489; G 7996; G 8000; G 8431; P 29934; H 176; H 254; Sp 1591
C. macrocephalus Liebm. — C 23370
C. mutisii (H.B.K.) Griseb. — H 477
C. ochraceus Vahl — C 24007; C 24660; P 29928; Sp 1814
C. odoratus L. — C 24009; C 24579; G 7999; DEM 274; Dieck 161; P 29927
C. pallens (Liebm.) Standl. & Steyermark
C. peruvianus (Lam.) F.N. Williams — C 24111; DEM 515; Sp & St 2271; Sp & St 2343; Sp 2400; Sp 2469
C. planifolius L. Rich. — Lin 1; Lin 2; Lin 31; Lin 71; Sp & St 2202; Sp & St 2210; Sp & St 2216; Sp & St 2237; Sp & St 2257; Sp & St 2270; Sp & St 2272; Sp & St 2289; Sp & St 2324; Sp & St 2372; Sp & St 2385; Sp 2400; Sp 2408; Sp 2422; Sp 2503; Sp 2537; Sp 2560
C. polystachyos Rottb. — C 24105; C 24865A; D 11465
C. prolixus H.B.K. — D 10855
C. rotundus L. — C 24085
C. semiochraceus Boeck.
C. surinamensis Rottb. — G 7996
C. tenuis Sw. — K 419; K 426
C. unioloides R. Br. — H 98
Eleocharis caribaea (Rottb.) Blake — D & L 1255; G 7868; DEM 607
E. cellulosa Torr.
E. elegans (H.B.K.) R. & S. — C 24868; D 10760; DEM 259; H 175
**E. elongata* Chapm. — H 379
E. filiculmis Kunth — DEM 238; H 422; D & L 1670

E. flavescens (Poir.) Urban
E. interstincta (Vahl) R. & S.
E. maculosa (Vahl) R. & S. — E 170; H 415
E. minima Kunth — H 445
E. minutissima Britt.
E. montana (H.B.K.) R. & S. — D & L 12328
E. mutata (L.) R. & S. — Vaughn *et al.* 276B
E. nigrescens (Nees) Steud.
E. pachystyla (C. Wright) C.B. Clarke — H 377
E. retroflexa (Poir.) Urban
Fimbristylis annua (All.) R. & S.
F. autumnalis (L.) R. & S.
F. castanea (Michx.) Vahl
F. complanata (Retz.) Vahl — D 10855
F. dichotoma (L.) Vahl — D 9525A; H 618
F. milacea (L.) Vahl
F. spadicea (L.) Vahl — C 24095; D 11288; D & P 10037; Vaughn *et al.* 275
F. spathacea Roth — Sp & St 2445; Sp & St 2277; Sp & St 2377; Sp 2415; Sp 2511; Sp & St 2565
F. vahlii (Lam.) Link.
Fuirena bulbipes Blake — C 24043; C 24125; D 11377; G 7877; G 8529
**F. campotricha* C. Wright — H 97; H 329
F. incompleta Nees
F. simplex Vahl
F. umbellata Rottb. — P 29579
Hypolytrum longifolium (L. Rich.) Nees ssp. *nicaraguense* (Liebm.) Koyama — D & L 12067
Lagenocarpus guianensis Lindl. & Nees
Lipocarpa maculata (Michx.) Torr.
Rhynchospora barbata (Vahl) Kunth — C 23273; C 24082; D 10912A; G 8530; H 342; H 621; L & D 1683
R. cephalotes (L.) Vahl — C 23516; C 24786; G 8411; H 250
**R. chapmanii* M. A. Curt. — DEM 442
R. colorata (L.) H. Pfeiff. — C 23256; D 10931; G 7865; H 393

R. corymbosa (L.) Britt. — C 24067
R. curvula Griseb. — D & P 10050; H 337
R. cyperoides (Sw.) Mart. — C 23254; C 23341; C 23511; C 23820; C 23952; C 23963; C 24768; D 11070; D 11482A; D 12767; D & P 10017; G 7871; G 8528; H 169; H 237; Sp 1636
R. divergens M. A. Curt. — C 23260; C 24080A; D 10726; D 12420; D 12615
R. exaltata Kunth — D 11687
R. exima (Nees) Boeck. — D 9050
R. fascicularis (Michx.) Vahl — D 10406; D & P 10039
R. globosa (H.B.K.) R. & S. — D 11670; D 12709; D & P 10015; H 84; H 341
**R. globularis* (Chapm.) Small — C 23966; D & P 10076; G 7872; H 11; H 309; H 366
R. hirsuta Vahl — L & D 1666
**R. intermixta* C. Wright — D 10924; D 10925; D 11601; D 11609; D 10473A; D & P 10038; D & P 10132A; G 7867
R. marisculus Nees — H 291
R. micrantha Vahl
R. nervosa (Vahl) Boeck. — C 23532; C 24603; D 9829; DEM 238; DEM 355; G 8496; H 293; K 524; Sp 1531; Sp 1711
**R. oligantha* Gray — H 426
**R. plumosa* Ell. — C 24036; DEM 651; D & P 10132A
**R. podosperma* C. Wright — H 196
R. pusilla (Sw.) Griseb.
R. radicans (Cham. & Schlecht.) H. Pfeiff. — C 23366; C 23399; D 11131; G 7995
**R. rariflora* (Michx.) Ell. — C 24036A
R. robusta (Kunth) Boeck. — DEM 617; H 99
R. rugosa (Vahl) Gale — D 11612; DEM 651
R. setacea (Berg.) Boeck. — C 23277; DEM 651; L & D 1681
R. tenuis Link — DEM 442
**R. torresiana* Britt. & Standl. — H 230; P 29676
R. watsoni (Britt.) Davidse

Scirpus chilensis Nees & Meyen
**Schoenus nigricans* L. — H 386; L & D 1675
Scleria areolata Lundell
S. bracteata Cav. — C 23294; C 23933; C 23964; C 24001; D 12403; D & L 12233; H 156; L & D 1424
S. ciliata Michx. — C 23964; H 192
S. eggersiana Boeck. — C 24034 A
S. georgiana Core — C 23414; C 24080; D 10404; D 10717; H 321; L & D 1660; L & D 1664; L & D 1676; L & D 1684
S. hirtella Sw. — L & D 1679
S. interrupta L. Rich.
S. latifolia Sw. — C 24508; C 24836; DEM 529; D & L 12081
S. lithosperma (L.) Sw. — C 24921; D 11013; D 12753
S. macrophylla Presl
S. microcarpa Nees — D 11467; H 494
S. micrococca (Liebm.) Steud. — H 191
S. mitis Berg. — DEM 470
S. muehlenbergii Steud. — DEM 231; H 455
S. pauciflora Muhl.
S. pinetorum Britt.
S. pterota Presl — C 23672; C 23936; C 23971; C 24034; C 24536; C 24943; D 11012; D 11216; D 11380; DEM 545; G 8527; Spellman *et al.* 276
S. pterota Presl var. *melaleuca* (Reichenb.) Uittien — H 259; K 503
S. secans (L.) Urban — C 24143; C 24475; G 8527; H 493; Spellman *et al.* 276
S. setacea Poir.
S. verticillata Muhl. ex Willd.

Dioscoreaceae

N.B. A goodly number of very recent collections have not been identified (and hence not cited) due to the current state of confusion in the genus.

Dioscorea bartlettii Morton — Sp 1895; Sp 1904
D. bernoulliana Prain & Burkhill — H 267

D. convolvulacea Cham. & Schlecht. — Sp 1903; Sp 1918
D. esurientium Uline
D. macrostachya Benth.
D. polygonoides H. & B. ex Willd.
D. spiculiflora Hemsl.

Eriocaulaceae
Eriocaulon fulginosum C. Wright — H 383
E. schiedeanum Koern.
E. schippii Standl.
Paeplanthus gentlei Moldenke
P. lamarckii Kunth
Syngonanthus gracilis (Koern.) Ruhl
S. hondurensis Moldenke
S. lundellianus Moldenke
S. o'neillii Moldenke
Tonina fluviatilis Aubl.

Gramineae
Acroceras zizanioides (H.B.K.) Dandy
Andropogon bicornis L. — H 89
A. elliotti Chapm.
A. gerardi Vitman — Sp 1574; Sp 1644
A. glomeratus (Walt.) B.S.P. — C 24044; Lin 34; Lin 115; Lin 122; Sp & St 2210; Sp & St 2342; Sp & St 2376; Sp 2389
A. lateralis Nees
A. leucostachyus H.B.K. — C 24006; D 11506; D 12769; G 7861; G 7866
A. selloanus (Hack.) Hack. — H 144; H 430
A. virginicus L. — Sp 1642
Anthephora hermaphrodita (L.) Kuntze
Aristida arizonica Vasey
A. capillacea Lam. — H 339
A. divaricata H. & B.
A. implexa Trin. — H 79
A. laxa Cav. — L & D 1446; L & D 1667
A. liebmannii Fourn.
A. longifolia Trin.

A. orizabensis Fourn. — D 9107; H 419
A. purpurascens Poir. — G 7862
A. recurvata H.B.K. — H 303; H 417
**A. setifolia* H.B.K. — D 11604
A. tenuispica Hitchc. — C 23965; C 24081; D 11518
A. ternipes Cav.
**A. vilfifolia* Henr. — D & P 10051
Arundinella berteroniana (Schult.) Hitchc. & Chase — H 418
A. deppeana Nees — D & L 12229; H 385
Axonopus aureus Beauv. — H 141
A. ciliatifolius Swallen — H 83
A. compressus (Sw.) Beauv. — H 441
A. elongatus Swallen — H 490
A. poiophyllus Chase — H 391
A. purpusii (Mez) Chase
A. rhizomatosus Swallen
Bambusa vulgaris Schrad. ex Wendl.
B. swalleniana McClure — C 23424
**Bothriochloa bladhii* (Retz.) S. T. Blake — D 9921A
Brachiaria fasciculata (Sw.) Blake — C 23453; C 23456; C 24045; C 24918; D 11551; DEM 401; K 421; Sp 1816
B. mutica (Forsk.) Stapf — K 430
Cenchrus brownii R. & S. — C 24980; K 435; Sp 1795
C. echinatus L. — C 24096
**C. incertus* M.A. Curt. — Sp & St 2249; Sp & St 2364
Chloris barbata Sw. — C 24069
C. ciliata Sw.
C. radiata (L.) Sw. — C 23501; H 47
Cynodon dactylon (L.) Pers. — Dieck 184; K 697; Sp 244
**Dichanthium annulatum* (Forsk.) Stapf — D 11181
Digitaria cayonensis Swallen
D. ciliaris (Retz.) Koel.
D. fuscescens (Presl) Henr. — D 11602
D. horizontalis Willd. — C 23306; C 24108; Sp 1721
D. insularis (L.) Mez ex Ekman — K 583
D. multiflora Swallen
Distichlis spicata (L.) Greene

Echinochloa colonum (L.) Link — C 23311; D 11407
E. polystachya (H.B.K.) Hitchc. — D 10745
**Echinolaena gracilis* Swallen — D 10424B; H 334
Eleusine indica (L.) Gaertn. — C 23305; C 23307; C 23311; C 23502; G 8088; K 422; D 9840A; D 9853A; D 10403; Sp 1815
Eragrostis acutiflora (H.B.K.) Nees — G 8092
E. bahiensis Schrad. — D 9105
E. ciliaris (L.) R. Br. — H 453; K 576; Sp & St 2971; Sp 2446
E. domingensis (Pers.) Steud. — D 11457; D & P 10034; D & P 10036; D 11457; D 12149; Dieck 117; H 378; Lin 73; Lin 116; Lin 117; Lin 119; Sp & St 2252; Sp & St 2378; Sp 2405; Sp 2454
E. elliotii Wats.
E. hirsuta (Michx.) Nees — H 468
E. hypnoides (Lam.) B.S.P.
E. lugens Nees
E. maypurensis (H.B.K.) Steud. — D 10403; D & L 12147; D & L 12212; H 194
E. mexicana (Hornem.) Link
E. prolifera (Sw.) Steud.
E. tenella (L.) R. & S.
Eriochloa punctata (L.) Desv. ex Hamilt.
Eriochrysis cayennensis Beauv.
Eustachys petraea (Sw.) Desv. — Lin 35; Lin 75; Lin 121; Lin 163; Sp & St 2362; Sp & St 2236; Sp & St 2250; Sp & St 2410; Sp 2437
Gymnopogon spicatus (Spreng.) Kuntze
Gynerium sagittatum (Aubl.) Beauv.
Hackelochloa granularis (L.) Kuntze
**Hemarthria* cf. *altissima* (Poir.) Stapf. & C.E. Hubb. — Sp & St 2368
Homolepis aturensis (H.B.K.) Chase — C 23634; C 24060; H 101
Hymenchne amplexicaulis (Rudge) Nees — C 23432
Hypogynium virgatum (Desv.) Dandy — C 24192; D 11067; D & L 12364; DEM 613; H 271; L & D 1672

Ichnanthus axillaris (Nees) Hitchc. & Chase
I. brevivaginatus Swallen
I. lagotis (Trin.) Swallen — H 434
I. lanceolatus Scribn. & Smith — D 11379
I. mexicanus Fourn.
I. nemoralis (Schrad.) Hitchc. & Chase
I. pallens (Sw.) Munro ex Benth.
I. scaberrimus Swallen
I. standleyi Hitchc.
I. tenuis (Presl) Hitchc. & Chase
I. villosus Swallen
Imperata brasiliensis Trin. — K 563
I. contracta (H.B.K.) Hitchc.
Isachne sp. — C 24019
I. polygonoides (Lam.) Doell.
Ischaemum latifolium (Spreng.) Kunth — C 24184; C 24878; D 10466; D 11379; D & L 12192; L & D 1432
Lasiacis divaricata (L.) Hitchc. var. *divaricata* — C 23649; C 23707; C 3924; C 24420; D 9957; D 10971; D 11155; D & L 12030; D & L 12209; Sp 1713
L. grisebachii (Nash) Hitchc. var. *grisebachii* — C 23334; C 23398; DEM 544 B; L & D 1483; Sp 1598; Sp 1661
L. oaxacensis (Steud.) Hitch. var. *oaxacensis* — DEM 544 A; K 651; L & D 1588
L. procerrima (Hack.) Hitchc. — C 24416; D 11194; D 11416; D & L 12075
L. rugelii (Griseb.) Hitchc. var. *rugelii* — C 24770; C 24990; D 12757; D & L 12284; H 266; P 29950
L. ruscifolia (H.B.K.) Hitchc. var. *ruscifolia* — D 11005
L. sloanei (Griseb.) Hitchc. — C 23912; K 588; Sp 1888
L. sorghoidea (Desv.) Hitchc. & Chase var. *sorghoidea* — K 697
Leersia hexandra Sw.
L. ligularis Trin. var. *breviligularis* (Prod.) Pyrah — C 23496
Leptochloa domingensis (Jacq.) Trin
L. filiformis (Lam.) Beauv.

L. uninerva (Presl) Hitchc. & Chase
L. virgata (L.) Beauv. — C 23454; K 405; Sp 1731
Leptocoryphium lanatum (H.B.K.) Nees — G 7869
Merostachys pauciflora Swallen
Mesosetum blakei Swallen — H 346
M. filifolium F.T. Hubb. — D 10041; D & P 10020; G 7870; H 85
Olyra latifolia L. — C 23943; C 24671; DEM 373; G 7847; Sp 1586; Sp 1659; Sp 1924; Sp 1965
O. yucatana Chase — C 23395; C 23478; C 23604; C 23894; L & D 1511
Oplismenus burmannii (Retz.) Beauv. — K 532
O. hirtellus (L.) Beauv.
O. setarius (Lam.) R. & S. — P 29842
Oryza alta Swallen
O. latifolia Desv.
O. sativa L.
Panicum agrostoides Spreng.
P. albomarginatum Nash — Sp 1631
P. altum Hitchc. & Chase
P. aquaticum Poir.
P. bartlettii Swallen — C 23332; C 23387; K 551
P. cayennense Lam.
P. cayoense Swallen
P. chamaelonche Trin.
P. cyanescens Nees ex Trin. — C 24185A; G 8051; H 211; H 344
P. erectifolium Nash — C 23259; C 24077; D 10716
P. frondescens Mey. — D 11469
P. furtivum Swallen — H 451
P. fusiforme Hitchc. — H 308; DEM 449
P. ghiesbreghtii Fourn.
P. hirsutum Sw. — C 23483; C 23664; C 24285; K 461
P. hirtum Lam.
P. ichnanthoides Fourn.
P. lancearium Trin.
P. lanuginosum Ell. — H 10

P. laxum Sw. — C 23537; C 23967; C 24025; C 24121; C 24185; C 24860; C 24930; D 10755; DEM 273; K 698; Lin 74; Lin 123; H 442; H 458
P. longiligulatum Nash
P. lundellii Swallen
P. maximum Jacq. — D 12717; K 662
P. milleflorum Hitchc. & Chase
P. neuranthum Griseb.
P. olivaceum Hitchc. & Chase — D 9110
P. parvifolium Lam. — H 495
P. parviglume Hack.
P. patulum (Scrib. & Merr.) Hitchc.
P. pilosum Sw. — C 24880; Sp 1600; Sp 1693
P. polycaulon Nash — H 9
P. polygonatum Schrad. — C 24516; C 24517; G 7956
P. pulchellum Raddi — DEM 173
P. rudgei R. & S. — DEM 454; H 332
P. sellowii Nees — H 463
P. sphaerocarpon Ell.
P. stagnatile Hitchc. & Chase
P. stenodoides F.T. Hubb.
P. tenerum Beyr. ex Trin. — H 497
P. *trichanthum* Nees
P. trichoides Sw. — C 24867; G 7989; G 8450; K 455
P. tuerkheimii Hack.
P. virgatum L. — K 687
P. viscidellum Scribn. — C 23391; C 23398A; C 24077A; H 253
P. wrightianum Scribn. — Sp 1514
Paspalum blodgettii Chapm. — C 23939; C 24046A; H 448
P. botterii (Fourn.) Chase — C 23626; C 23668; C 23700; C 24769
P. caespitosum Flügge — C 23626; C 23668; C 23771; D 10779
P. clavuliferum C. Wright
P. conjugatum Berg. var. *conjugatum* — C 23302; C 24098; C 24262; C 24693; DEM 176; H 285; Sp 1666

P. conjugatum var. *pubescens* Doell — Sp 1599
P. conspersum Schrad. ex Schult.
P. convexum H. & B. — H 195
P. corcovadense Raddi — G 8607; H 440
P. coryphaeum Trin.
P. decumbens Sw. — C 24421; C 24520
P. distichum L. — Sp 2465; Sp 2487; Sp 2509; Sp 2531; Sp & St 2464
P. fasciculatum Willd. ex Flügge — C 24130; C 24135; C 24183
**P. fimbriatum* H.B.K. — C 23455; C 24612; DEM 242; S 1722
P. humboldtianum Flügge — H 462
P. langei (Fourn.) Nash — C 23828
**P. laxum* Lam. — H 442; H 458; Sp & St 2276
**P. lineare* Trin. — Sp 1513
P. millegrana Schrad. — C 24769; D 11291; D 12469
P. minus Fourn. — H 165; H 439
P. multicaule Poir. — H 336
P. notatum Flügge
P. nutans Lam.
P. orbiculatum Poir.
P. paniculatum L. — C 23789; H 154
P. peckii F.T. Hubb.
P. pectinatum Nees — H 80
P. pilosum Lam.
P. plicatulum Michx. — C 24033A; C 24130
P. pulchellum Kunth — C 23997; C 24033; D 11092; G 7859; G 7864; H 88; Sp 1641
P. repens Berg.
P. serpentinum Hochst. ex Steud. — C 24033; G 7863
P. vaginatum Sw. — C 24047; C 24099
P. virgatum L. — C 23309; C 23457; C 24107; D 9859A; D 11339; DEM 175; DEM 276; G 7957; Lin 36; Lin 72; Lin 120; Lin 204A; Sp 1732
Pennisetum complanatum (Nees) Hemsl. — DEM 114
P. nervosum (Nees) Trin.
P. setosum (Sw.) L. Rich.

Pharus latifolius L. — C 24542; Sp 1615; Sp 1602
P. parvifolius Nash — G 8175
Phragmites australis (Cav.) Trin. ex Steud. — D 10383; H 297; L & D 1440
Rhipidocladum bartlettii (McClure) McClure
Rhynchelytrum repens (Willd.) C.E. Hubb. — L & D 1445
Rottboellia exaltata L.f.
Saccharum officinarum L.
Sacciolepis myuros (Lam.) Chase
Schizachyrium brevifolium Nees ex Kunth
S. hirtiflorum Nees
S. microstachyum (Desv.) Roseng., Arr. & Izag. — D 11206, D 12632; DEM 540
S. semiberbe Nees — L & D 1671
S. tenerum Nees
Setaria scandens Schrad. ex Schult. — H 483
S. geniculata (Lam.) Beauv. — C 24051; C 24984; Sp 1692; Sp 1768
S. grisebachii (Steud.) Fourn.
S. tenacissima Schrad. ex Schult.
S. tenax (L. Rich.) Desv. — H 421
S. vulpiseta (Lam.) R. & S.
Sorgastrum setosum (Griseb.) Hitchc. — H 20
Sorghum halepense (L.) Pers. — DEM 650
Spartina spartinae (Trin.) Merr. — D 11397; D & P 10035; G 8372; Lin 168; Sp & St 2206; Sp 2291; Sp 2553; Sp 2562
Sporobolus buckleyi Vasey
S. cubensis Hitchc. — H 82
S. indicus (L.) R. Br. — H 108; Sp 1730
S. jacquemontii Kunth — C 23308; C 23875; C 24163; C 24992; D 9838A; D 9995A; D 11167; D 11408; D 12431
S. virginicus (L.) Kunth — C 24093; D 11475; Lin 4; Lin 168; Lin 204; Sp 2182; Sp 2526; Sp & St 2234; Sp & St 2275; Sp & St 2286; Sp & St 2382; Sp 2414; Sp 2462; Sp 2508; Sp 2526; Sp 2573
Stenotaphrum secundatum (Walt.) Kuntze

Streptochaeta sodiroana Hack.
Thrasya camplostachya (Hack.) Chase — H 437; H 614
T. thrasyoides (Trin.) Chase
Trachypogon angustifolius (H.B.K.) Nees ex Hack. — H 86; H 488
T. montufari (H.B.K.) Nees
Triplasis purpurea (Walt.) Chapm.
Tripsacum dactyloides L.
T. latifolium Hitchc. — D & L 12211; H 315
T. laxum Nash
Zea mays L.

Haemodoraceae
Xiphidium caeruleum Aubl.

Hydrocharitaceae
Thalassia testudinum Konig

Hypoxidaceae
Hypoxis decumbens L. — H 153; Sp 1516; Sp 1629

Iridaceae
Cipura paludosa Aubl. — D 12801
Marica gracilis Herb.
Nemastylis bequaertii Standl.
N. sylvestris (Loes) Loes (= *Eustylis sylvestris* Loes) — D & P 10064
Sisyrinchium tinctorium H.B.K. — DEM 216; P 29857

Juncaceae
**Juncus marginatus* Rotsk. — D 10754

Liliaceae
Allium cepa L.
A. sativum L.
Dracaena americana J. D. Sm. — D 9967; D 12602; P 30028; Sp 1709A; Sp 1713A; Sp 1891
Echeandia sp. — H 109
Yucca elephantipes Reg.

Marantaceae
Calathea albicans Brong.
C. altissima (P. & E.) Koern.

C. barbillana Cuf. — G 7889; G 8179; G 8479
C. insignis Peters — C 24374; G 7943; G 8594
C. lutea (Aubl.) Mey. — C 24268; D 9877; DEM 538; G 8034; P 30229
C. macrosepala Schum.
C. microcephala (P. & E.) Koern. — C 24440; G 8181; G 8588; V 635
Ischnosiphon morlaei (Eggers) Schum. — C 24400
Maranta arundinacea L. — C 23874; C 24444; D 9975; DEM 131; G 1835; G 8148; K 678; Sp 1568
Myrosma guapilesense J. D. Sm.
Pleiostachya pruinosa (Reg.) Schum.
Stromanthe lutea (Jacq.) Eichl. — D 11311
Thalia geniculata L. — C 23991

Mayacaceae

Mayaca aubletii Michx.
M. fluviatilis Aubl. — P 29427

Musaceae

Heliconia acuminata L. Rich.
H. aurantiaca Ghiesbr.
H. bourgaeana O.G. Peters.
H. champneiana Griggs
H. collinsiana Griggs
H. hirsuta L.f. var. *rubriflora* R.R. Sm.
H. latispatha Benth. — C 23305; C 24903; DEM 581; Sp 1681; P 29923
H. mariae Hook.f.
H. pendula Wawra
H. psittacorum L.f. — Sp 1963
H. schiedeana Kl. — D 10815; DEM 235
H. spissa Griggs — P 30154
H. cf. *subulata* R. & P. — Sp 1603
H. vaginalis Benth. — D 9870; G 8144; G 8248; V 599
H. wagneriana O.G. Peters. — C 24273

Naiadaceae

Nais guadalupensis (Spreng.) Morong

Orchidaceae
Bletia purpurea (Lam.) DC — D 10464; G 7606; H 498
Brassavola nodosa (L.) Lindl. — H 411
Campylocentrum micranthum (Lindl.) Rolfe
C. sullivanii Fawc. & Rendle
Catasetum integerrimum Hook. — H 126
Cattleya skinneri Batem. — H 50
Chysis bractescens Lindl.
Coryanthes picturata Reichenb. f. — P 30276
C. speciosa Hook.
Corymborchis flava Kuntze
Cranichis sylvatica A. Rich. & Gal. — H 289
Cycnoches chlorochilon Kl.
C. warscewiczii Reichenb. f. — Sp 1952
Diacrium bidentatum (Lindl.) Hemsl.
Dicrium bilamellatum (Reichenb. f.) Hemsl. (= *Caularthron bilamellatum* (Reichenb. f.) Schult.)
Dichaea tuerckheimii Schltr.
Elleanthus linifolius Presl
Encyclia bractescens (Lindl.) Hoehne
E. cochleata (L.) Dressler — G 7818; Sp 1581
Epidendrum alatum Batem.
E. anceps Jacq. — P 30091
E. belizense Reichenb. f.
E. boothianum Lindl.
E. boothii (L.) L.O. Wms.
E. ciliare L.
E. clowesii Batem. ex Lindl.
E. cochleatum L. — G 7818; H 127; P 29905
E. condylochilum Lehm. & Kranzl
E. difforme Jacq.
E. imatophyllum Lindl. — P 30275
E. isomerum Schltr. — P 29774
E. nocturnum Jacq.
E. paniculatum R. & P.
E. polyanthum Lindl.
E. polybulbon Sw.
E. pygmaeum Hook.

E. radiatum Lindl.
E. rigidum Jacq. — P 29597
E. stamfordianum Batem.
E. stenopetalum Hook.
E. verrucosum Sw. — P 29433
Erythrodes purpurea Ames
Eulophia alata (L.) Fawc. & Rendle
E. longifolia (Kunth) Schltr.
Galeandra batemanii Rolfe
G. baueri Lindl.
Gongora maculata Lindl.
G. cf. *quinquenervis* R. & P. — D 9939; G 8039; G 8134
Habenaria lankesteri Ames
H. mesodactyla Griseb.
H. odontopetala Reichenb. f.
H. cf. *pauciflora* (Lindl.) Reichenb. f.
H. repens Nutt.
H. setifera Lindl.
Ionopsis utricularioides (Sw.) Lindl.
Isochilus crassiflorus A. Rich. & Gal.
I. linearis (Jacq.) R. Br. var. *carnosiflorus* (Lindl.) Correll
Laelia digbyana Benth.
L. tibicinis (Batem. ex Lindl.) L.O. Wms. — H 327
Lycaste cochleatam Lindl. ex Paxt.
Macradenia brassavolae Reichenb. f.
Masdevallia tubuliflora Ames
Maxillaria crassifolia (Lindl.) Reichenb. f.
M. densa Lindl.
M. friedrichsthalii Reichenb. f. — P 29774; P 29827; P 29687
M. macleei Batem
M. ringens Reichenb. f.
M. tenuifolia Lindl. — P 30188
M. uncata Lindl. — P 29686
Mormodes buccinator Lindl.
M. ringens (Lindl.) Schlecht.
Notylia barkeri Lindl.
N. trisepala Lindl & Paxt.

Oncidium ascendens Lindl.
O. carthagenense (Jacq.) Sw. — H 132
O. cebolleta (Jacq.) Sw. — H 137
O. ensatum Lindl. — DEM 461
O. luridum Lindl.
O. pusillum (L.) Reichenb. f. — D 9938; H 410
O. sphacelatum Lindl. — H 396?
Ornithocephalus inflexus Lindl.
O. pottsiae Wats.
Pleurothallis blaisdellii Wats.
P. brighamii Wats. — C 24156
P. marginata Lindl. — H 136
P. racemiflora (Sw.) Lindl.
P. yucatanensis Ames & Schweinf.
Polystachya cerea Lindl.
P. clavata Lindl. — H 128?
P. luteola (Sw.) Hook.
P. masayensis Reichenb. f.
P. minor Fawc. & Rendle
Ponera striata — Lindl.
Rhyncholaelia digbyana (Lindl.) Schltr. — H 133
Scaphyglottis behrii (Reichenb. f.) Benth & Hook. ex Hemsl.
S. cuneata Schltr.
S. wereklei Schultz var. *major* Schweinf.
Sobralia decora Batem.
S. fragrans Lindl.
S. macrantha Lindl. — DEM 460; H 51
Spiranthes acaulis (J. E. Sm.) Cogn.
S. graminea Lindl. — Sp 1623?
S. lanceolatus Fawc. & Rendle
S. orchidioides (Sw.) A. Rich. — DEM 537
S. squamulosus Fawc. & Rendle
S. tortilis (Sw.) L. Rich. — H 220
Stelis ciliaris Lindl.
Stenorrhynchos lanceolatus (Aubl.) Griseb. — H 404
Trigonidium egertonianum Batem. ex Lindl. — P 30222
Vanilla fragrans (Salisb.) Ames

Palmae

Acrocomia belizensis Bailey

A. mexicana Karw. ex Mart.

A. panamensis Bailey — C 23916; Sp 1832

Asterogyne martiana Wendl. ex Hook. f. — C 24524

Asterocaryum mexicanum Liebm. — C 23735; C 24165; C 24455; D 10906; G 8143

Bactris major Jacq. (including *B. balanoides* (Oerst.) Wendl.) — C 23437

B. trichophylla Burret — C 23972; C 24340; C 24788; D 11101; Sp 1686

Calyptrogyne donnell-smithii (Dammer) Burret — C 24381

Chamaedorea adscendens (Dammer) Burret

C. arenbergiana Wendl.

C. elegans Mart.

C. ernesti-angusti Wendl. — C 23335; C 24306; D 10148; D & L 10907; G 7735; G 7831; G 7980; G 8129; Sp 2005

C. erumpens Moore

C. geonomaeformis Wendl.

C. lindeniana Wendl. *sp. vel aff.* — C 23318; C 24296; C 24382; G 7734

C. neurochlamys Burret

C. oblongata Mart. — G 7828

C. schippii Burret — G 7831A

C. wendlandiana Hemsl. — C 23816; C 24564; D 11107; D 11441; G 7854; G 7976; G 8309; G 8599

Cocos nucifera L.

Crysophila argentea Bartlett — C 23789A; D & L 12251; L & D 1621; Sp 1892

C. warscewiczii (Wendl.) Bartlett, *sp. vel aff.* — C 23605

Desmoncus ferox Bartlett — C 23338; C 24746; D 11352

D. leiorhachis Burret

D. quasillarius Bartlett

D. schippii Burret — D 10958; G 8035; Sp 1685; Sp 1882

Euterpe macrospadix Oerst.

Geonoma binerva Oerst.
G. longipetiolata Oerst.
G. oxycarpa Mart. (including *G. mexicana* Liebm.) — C 24468; D 10921; D 11312; D & L 12096; G 7987
Opisandra maya Cook.
Orbignya cohune (Mart.) Dahlg. ex Standl. — C 23444; Sp 1687
Paurotis schippii Burret
P. wrightii (Griseb. & Wendl.) Britt. ex Britt. & Schafer — C 23267; C 23953; D 10478; D 10977; Dwyer *et al.* 365; G 8055; Sp 1617; Sp & St 2356
Reinhartia gracilis (Wendl.) Burret var. *gracilis*
R. gracilis var. *gracilior* (Burret) H.E. Moore
R. latisecta (Wendl.) Burret
Roystonea oleracea (Jacq.) Cook
R. regia (H.B.K.) Cook
Sabal mayarum Bartlett
S. morrisiana Bartlett — Sp 1893
S. nematoclada Burret
Scheelea sp. — C 23436; G 8596
Schippia concolor Burret — C 24814; G 8422
Synnechanthus fibrosus Wendl. — C 24527; C 24556; D 11309; Sp 2015A
Thrinax radiata Lodd. — Sp & St 2145; Sp & St 2222; Sp & St 2298; Sp & St 2357; Sp & St 2417; Sp & St 2476; Sp & St 2557. We follow Reed (*Principes* 18: 39. 1974) in the usage of this name in preference to *T. parviflora* Sw. and *T. floridana* Sarg.

Pontederiaceae
Eichornia crassipes (Mart.) Solms
Heteranthera reniformis R. & P. — P 29942
Pontederia lanceolata Nutt. — P 30311
P. rotundifolia L.

Potamogetonaceae
Potamogeton lucens L.
P. pectinatus L.
Ruppia maritima L.

Smilacaceae
Smilax domingensis Willd. — K 488
S. gentlei Lundell
S. lanceolata L.
S. lundellii Killip & Morton
S. mexicana Griseb. ex Kunth
S. mollis H. & B. — G 8492; Sp 1663; Sp 1878
S. munda Killip & Morton
S. ornata Lem.
S. spinosa Mill. — DEM 1913; G 8043
S. velutina Killip & Morton — D & L 12210; D & L 12275; H 436; P 29626; P 29765

Triuridaceae
Sciaphila picta Miers

Typhaceae
Typha angustifolia L.

Xyridaceae
Xyris ambigua Bey. ex Kunth — Sp 1627
X. caroliniana Walt. — H 172
X. jupicai L. Rich. — C 24021; DEM 32; D & P 10063; Sor 7091; Sor 7139
X. navicularis Griseb. — D 10407
X. smalliana Nash — C 24015; D 10410; D 11610; D 11068
X. subnavicularis Malme — H 199?
X. subulata R. & P. — Dieck 101

Zingiberaceae
Alpinia speciosa (Wendl.) Schum.
Costus congestus Rowlee — Sp 1966; Sp 2001
C. pulverulentus Presl — D & L 12098; G 7731; G 7850; G 7910; G 7919; G 8002; G 8115
C. cf. *ruber* Griseb. — Sp 1683; Sp 1911; Sp 1917
C. spicatus (Jacq.) Sw.
C. villosissimus Jacq. — DEM 185; Sp 1684
Hedychium coronarium Koenig — D 11193; G 8233
Renealmia aromatica (Aubl.) Griseb.
R. exaltata L.f. — D 9931; L & D 1458
R. mexicana Kl.

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NOTES ON THE LEGUMINOSAE II. FACULTATIVE DWARFISM IN CROTALARIA SAGITTALIS L.[1]

DONALD R. WINDLER[2]

In his study of the North American species of *Crotalaria*, based on herbarium specimens, Senn (1939) described a dwarf *Crotalaria sagittalis* L. from rocky, xeric habitats in the American Southwest and Mexico to which he gave the name, variety *Blumeriana*. During the fall of 1967, while studying unifoliolate species of *Crotalaria* in North America (1970), I was able to observe a number of Mexican populations of this dwarf form in the field. In most locations visited, larger plants of *C. sagittalis* were often found growing in more favorable areas, near populations of variety *Blumeriana*. The consistency of this association seemed to place the status of the variety in question.

In the summer of 1968 plants reared from seeds of two "*Blumeriana*" populations (*Windler & Windler* 2950 — State of Jalisco; *Windler & Windler* 2981 — State of Oaxaca) were planted along with representatives of other species in a common garden plot at the North Carolina Botanical Gardens. A total of 47 plants, progeny of eleven seed parents from the two field populations, were grown. All plants grown in the garden plots were substantially larger than their field grown parents (see Figures 1 & 2). Plants from the field populations rarely grew to one decimeter in height and were mostly less than 0.7 dm. tall. Garden grown offspring of these plants grew to heights of three to seven decimeters. In addition to stem length, substantial increases were also observed in fruit size and number of fruits per plant. Garden plants from the dwarf seed parents com-

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[2]Contribution number 4 from the Towson State College Herbarium, Baltimore, Maryland 21204. Cost of publication of illustrations assisted by the Towson State College Faculty Research Fund.

Figure 1. A. Herbarium specimen of *Crotalaria sagittalis* "var. *Blumeriana*". B. A branch of a specimen grown from seed produced by the plant shown in Figure 1A.

Figure 2. A. Herbarium specimen of *Crotalaria sagittalis* "var. *Blumeriana*". B. A branch of a specimen grown from seed produced by the plant shown in Figure 2A.

pared favorably in general size with those from non-dwarf seed parents.

During preparation for the garden plantings, seeds were scratched and soaked overnight before being placed in the soil. At planting time, the 47 seeds from the dwarf populations were swollen and the radical was strongly exserted from the seed coat. In contrast, among the more than 1,000 seeds from 62 other North American *Crotalaria* populations, all were swollen at planting time but none showed an exserted radicle.

DISCUSSION

Based upon the above information, the plants that Senn recognized as var. *Blumeriana* appear to be ecophenes of Mexican *Crotalaria sagittalis* ecotypes that are adapted to xeric, rocky conditions where moisture becomes available but is soon depleted. Under these conditions organisms must produce seeds which germinate quickly, and the resulting plants must quickly develop to a physiological stage conducive to flowering and fruit set if the population is to continue to exist. Plants of most other *Crotalaria* populations in North America have not evolved under similar pressures and have not developed the quick germination response shown by the Mexican dwarf plants.

The ability to germinate quickly and produce seed at a small plant size appear to be genetically controlled, but the latter characteristic is not expressed unless the plant is developing in a xeric situation. Consequently no formal recognition should be accorded to the epithet *Blumeriana*.

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PECTIS HUMIFUSA NEW TO THE FLORA OF THE UNITED STATES

During research preparatory to a revision of section *Pectis* of the genus *Pectis* L. (Compositae), a new record for the flora of the United States was discovered. A specimen of *Pectis humifusa* Swartz, a taxon distributed among several islands of the Caribbean region, was found to have been collected in southern Florida. This first mainland record for *P. humifusa* is a significant range extension, since the closest previous collection site is over 900 miles away in the Dominican Republic. The previously known range for this species extends from Tobago north through the Lesser Antilles to Puerto Rico and the Dominican Republic. The following are the collection data for this new record: UNITED STATES: Florida, Collier Co., Naples, in white sand along route 41, the Tamiami Trail, 5 mi. SE of town, 24 Mar 1956, *J. A. Churchill* s.n. (MSC).

Three other species of *Pectis* are known to occur in Florida: *P. leptocephala* (Cass.) Urban, *P. linearifolia* Urban and *P. prostrata* Cav. All are low herbs with yellow, five-rayed heads, as is *P. humifusa*. However, of the three previously known taxa, only *P. prostrata* bears a close resemblance to *P. humifusa*. The two taxa are similar in their prostrate habit, relatively broad leaves (usually more than 2 mm. wide) and very short-peduncled or sessile heads. The two species differ in several respects, however, and are easy to distinguish. Both species tend to root at the nodes, but the tendency is much more developed in *P. humifusa*. The foliage of *P. humifusa* is blue-green and the leaves are mostly 4-12 mm. long and 1.5-4 mm. wide, ranging from oblanceolate to obovate. The leaves of *P. prostrata* are more olive-green, commonly exceed 20 mm. in length and are at most oblanceolate. The heads of *P. humifusa* are more open at anthesis than those of *P. prostrata* and are commonly

campanulate rather than cylindric or urceolate. The involucral bracts of *P. humifusa* are obovate, obtuse, and keeled only part of their length whereas those of *P. prostrata* are usually lanceolate or oblanceolate, acute, and are keeled nearly to the tips. *Pectis humifusa* is a plant of sandy areas, and *P. prostrata* occurs in a variety of habitats and is a common roadside weed in much of Latin America.

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MARITIME AND MARINE LICHENS FROM NAHANT[1, 2]

E. E. WEBBER

The Marine Science Institute of Northeastern University, Nahant, Massachusetts, became operational in 1966; its first classes were offered during the summer of 1967. At that time, Dr. Ivan Mackenzie Lamb of the Farlow Herbarium made an initial collection (with determinations) of the lichens common to the environs of the laboratory. The majority of lichens collected encrust the extensive outcrops of rock which essentially encircle this research facility.

LICHEN DETERMINATIONS

A. Below are listed those maritime lichens occurring on the metamorphic rocks above the sea:

Acarospora fuscata (Schrad.) Arn.
Caloplaca scopularis (Nyl.) Lett.
(Sect. *Gasparrinia*)
Candelariella aurella (Hoffm.) Zahlbr.
Lecanora dispersa (Pers.) Somm.
Lecanora (*Aspicilia*) *gibbosula* Mogn.
Lecanora rubina (Vill.) Ach.
(Sect. *Placodium*)
Parmelia conspersa (Ach.) Ach.
(Sect. *Xanthoparmelia*)
Rhizocarpon grande (Flörke ex Flot.) Arn.
Rhizocarpon distinctum Th. Fr.
Dimelaena oreina (Ach.) Norm.

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[1]This list is published with the permission of Dr. I. M. Lamb, whose extreme generosity in this regard is sincerely appreciated.

[2]Contribution No. 25 from the Marine Science Institute, Nahant, Mass. 01908.

B. The following marine lichens appear as black, tar-like coatings on rock; the first is found in the spray zone, while the second is abundant in the intertidal:

Verrucaria erichsenii Zsch.
Verrucaria mucosa Wahlenb. ex Ach.

The above twelve lichens were collected during the course of one afternoon (Lamb, personal communication). Undoubtedly, additional species remain to be discovered.

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PHYCOLOGICAL STUDIES FROM THE MARINE SCIENCE INSTITUTE NAHANT, MASSACHUSETTS[1]

I. INTRODUCTION AND PRELIMINARY TABULATION OF SPECIES AT NAHANT

E. E. Webber

This is the initial paper in a series dealing with the attached marine algae at Nahant. These observations and studies began in the summer of 1968, and are continuing. The present paper summarizes the history of marine phycology in New England; this summary is followed by citations emphasizing recent research dealing with the local marine algal vegetation. A tabulation of the species found in the vicinity of Nahant is then presented. No attempt is made at this time to discuss the plants listed since discussions of specific taxa will constitute the topics of future papers in this series.

INTRODUCTION

Published accounts of the marine algal vegetation of New England began essentially in the late 1800's. The Nahant area figured prominently in these studies. The efforts of such local investigators as Farlow, Collins, Davis, and others (see Taylor, 1957 for a thorough bibliography), extending from about 1880 to the early part of this century, resulted in the cataloging of the seaweeds common along the open coast. Early field work emphasized the macroscopic algae of the littoral and upper littoral zones of the shoreline. Study of New England marine algae progressed through the 1920's and 1930's, culminating in the appear-

[1]Contribution No. 24 from the Marine Science Institute. I wish to thank Dr. A. C. Mathieson for his valuable suggestions during the writing of this paper.

ance of Taylor's (1937) phycological survey of the northeastern coast of North America. Twenty years later, recognizing the need for both an updating of information and the inclusion of new data, Taylor published a revision (1957) of his volume. This major contribution is still the basic reference for phycologists interested in the benthic marine algae of our northeastern coast.

From 1957 to the present, marine phycological studies in New England have progressed rapidly along several fronts. The utilization of SCUBA diving equipment has enabled the marine phycologist to study more accurately the heretofore inaccessible sublittoral zone; in addition, this technique has permitted field research on a year-round basis. The following may be cited as recent examples of SCUBA-aided research in New England waters: Lamb & Zimmermann, 1964; Hehre & Mathieson, 1970; Sears & Wilce, 1970; Hehre *et al.*, 1970; Adey, 1970; Wilce, 1970; and Mathieson, *et al.*, Nova Hedwigia, in press.

Several important phycological discoveries have resulted from recent intensive field studies. For example, the appearance of *Lomentaria clavellosa* in North America was reported from Massachusetts by Wilce & Lee, 1964; more recently, this species has been found in New Hampshire (Hehre, 1972).

Also from New Hampshire has come the first record of the occurrence of *Halicystis ovalis* along the northeastern coast of North America (Mathieson & Burns, 1970). This raises the larger question: is there a *Halicystis-Derbesia* alternation occurring in nature among the New England populations of these algae, for *Derbesia* is common to the sublittoral of our area (Sears & Wilce, 1970)?

In addition, year-round field studies have established the presence of two rare and monotypic brown algal crusts (*Petroderma maculiforme* and *Porterinema fluviatile*) known previously only from the Arctic, and now recorded for New England from Ipswich, Massachusetts (Wilce, Webber, & Sears, 1970). More specifically, this publication

presents the first report of *Petroderma* in Massachusetts, as well as the first record of the occurrence of *Porterinema* in North America. This latter taxon had been described previously only from the Baltic. For detailed discussions of the morphology, cytology, reproductive periodicities, and geographical distributions of these two "fleshy crusts", the reader is referred to the above paper. A comprehensive updating and summation of both brown and red algal "fleshy crusts" in New England has been presented by Wilce (1971).

Complementing the renewed vigor in research on the algae of the sublittoral zone, recent attention also has been focused on estuaries and their adjacent salt marshes. In New England, particularly, these ecosystems represent promising areas of study for the marine phycologist. Published accounts of the benthic algal vegetation of our salt marshes are few; the majority of species common to such interesting habitats are microscopic, and many, undoubtedly, have been overlooked by previous investigators. Publications relative to New England salt marsh algae are, therefore, recent in their appearance. While such publications are essentially ecologically oriented, they also deal with problems in systematics, life history studies, and polymorphisms of certain of the species encountered. The following papers may be mentioned as examples of recent studies centered about salt marsh ecosystems: Blum, 1960, 1968; Blum & Conover, 1953; Blum & Wilce, 1958; Webber, 1967, 1968, 1971; Webber & Wilce, 1971, 1972; and Mathieson & Fralick, 1972. The works of Drouet (1968) and Blum (1972), although not dealing entirely with New England salt marsh algae, do contain some phycological data applicable to this area.

An even greater void in our understanding of the attached marine algae relates to the autecology of particular species. To date, comparatively few autecological studies have been undertaken. Examples of New England seaweeds in both field and laboratory settings include the following: Kanwisher, 1957, 1966; Conover, 1958; Mathieson & Burns,

1971; Burns & Mathieson, 1972a, 1972b; Fralick & Mathieson, 1972, 1973; and Jordan & Vadas, 1972.

PRELIMINARY SPECIES TABULATION

The species listed in the following tabulation have been collected and examined by me. I acknowledge the advice of Dr. F. Drouet concerning several of the bluegreen algal determinations; Dr. C. van den Hoek for assistance with species of *Cladophora;* Dr. H. W. Johansen for advice on the Coralline algae; and Dr. R. T. Wilce for confirmation of the *Peyssonnelia* determination.

The systematic treatment of the Cyanophycophyta follows that of Drouet and Daily (1956); Drouet (1962, 1963, 1964, 1968); Fan (1956); and Tilden (1910). The treatments of the Chlorophycophyta, Phaeophycophyta, and Rhodophycophyta all essentially follow Taylor (1957), with the following exceptions: van den Hoek (1963) was followed for *Cladophora,* while the recent studies of Bliding (1963, 1968) were consulted for the Ulvales; species designations in *Ectocarpus* are after Rosenvinge & Lund (1941) and Cardinal (1964), *Petroderma* follows Waern (1952), and Powell's study (1957) was used for *Fucus,* and that of Wilce (1965) for *Laminaria.* The Chrysophycophyta (excluding diatoms) are treated in this paper following Taylor (1957) for the Vaucheriales, and Parke and Dixon (1968) for the Ochromonadales.

Cyanophycophyta

Anabaena torulosa (Carm.) Lag.
Calothrix crustacea (Thur.) Fan
Coccochloris stagnina Spreng.
Entophysalis deusta (Menegh.) Dr. et D.
Lyngbya lutea (Ag.) Gom.
Microcoleus chthonoplastes Thur.
M. lyngbyaceus (Kütz.) Crouan
M. vaginatus (Vaucher) Gom.
Nodularia harveyana (Thwaites) Thur.
N. spumigena Mert.

Chlorophycophyta

Blidingia minima (Näg. ex Kütz.) Kylin
Brachiomonas sp.
Bryopsis plumosa (Huds.) C. Ag.
Capsosiphon fulvescens (C. Ag.) S. et G.
Chaetomorpha linum (Muell.) Kütz.
C. melagonium (Weber & Mohr) Kütz.
Chlorochytrium moorei Gardner
Cladophora albida (Huds.) Kütz.
Codiolum gregarium A. Br. f. *intermedium* (Fos.) Collins
Enteromorpha flexuosa (Wulfen ex Roth) J. Ag.
E. intestinalis (L.) Link
E. intestinalis (L.) Link f. *clavata* J. Ag.
E. linza (L.) J. Ag.
E. linza (L.) J. Ag. var. *oblanceolata* Doty
Percursaria percursa (C. Ag.) Bory
Prasinocladus lubricus Kuck.
Prasiola stipitata Suhr
Rhizoclonium tortuosum Kütz.
Spongomorpha arcta (Dillw.) Kütz.
S. lanosa (Roth) Kütz.
S. spinescens Kütz.
Ulothrix flacca (Dillw.) Thur.
Ulva gigantea (Kütz.) Bliding

Phaeophycophyta

Agarum cribosum (Mert.) Bory
Alaria esculenta (L.) Grev.
Ascophyllum nodosum (L.) Le Jolis
Asperococcus echinatus (Mert.) Grev.
Chorda filum (L.) Stack.
Chorda tomentosa Lyngbye
Chordaria flagelliformis (Müll.) C. Ag.
Corynophlaea sp.
Desmarestia aculeata (L.) Lam.
D. aculeata (L.) Lam. var. *attenuata* Taylor
D. viridis (Müll.) Lam.

Dictyosiphon chordaria Aresch.
D. foeniculaceus (Huds.) Grev.
Ectocarpus confervoides var. *confervoides* (Roth) Kjellm.
E. confervoides var. *siliculosus* (Dillw.) Kjellm.
E. fasciculatus (Griff.) Harv.
Elachistea fucicola (Vell.) Aresch.
Fucus distichus L. ssp. *edentatus* (de la Pyl.) Powell
F. distichus L. ssp. *evanescens* (C. Ag.) Powell
F. vesiculosus L.
Laminaria saccharina (L.) Lam. sensu Wilce
L. digitata (Huds.) Lam.
Leathesia difformis (L.) Aresch.
Petalonia fascia (Muell.) Kuntze
Petroderma maculiforme (Woll.) Kuck.
Pylaiella littoralis (L.) Kjellm.
Ralfsia clavata (Harv. in Hook) Crouan
R. fungiformis (Gunn.) S. et. G.
R. verrucosa (Aresch.) J. Ag.
Scytosiphon lomentaria (Lyngbye) Link
Sphacelaria cirrhosa (Roth) C. Ag.
Streblonema aecidioides (Rosenv.) Fos.

Rhodophycophyta

Acrochaetium sp.
Agardhiella tenera (J. Ag.) Schmitz
Ahnfeltia plicata (Huds.) Fries
Antithamnion floccosum (Müll.) Kleen
Asparagopsis hamifera (Hariot) Okamura
Bangia fuscopurpurea (Dillw.) Lyngbye
Ceramium deslongschampii Chauvin var. *Hooperi* (Harv.) Taylor
C. rubriforme Kylin
C. rubrum (Huds.) J. Ag.
Chondrus crispus Stack.
Corallina officianalis L.
Clathromorphum circumscriptum (Strøm.) Fos.
Cystoclonium purpureum (Huds.) Batters

C. purpureum (Huds.) Batters var. *cirrhosum* Harv.
C. purpureum (Huds.) Batters f. *stellatum* Collins
Dumontia incrassata (Müll.) Lam.
Euthora cristata (C. Ag.) J. Ag.
Gigartina stellata (Stack.) Batters
Gloiosiphonia capillaris (Huds.) Carm.
Gracilaria verrucosa (Huds.) Papenfuss
Hildenbrandia prototypus Nardo
Lithothamnium sp.
Membranoptera alata (Huds.) Stack.
Petrocelis middendorfii (Rup.) Kjellm.
Peyssonnelia sp.
Phycodrys rubens (L.) Batters
Phyllophora brodiaei (Turner) J. Ag.
Phymatolithon laevigatum (Fos.) Fos.
Phymatolithon sp.
Polyides caprinus (Gunn.) Papenfuss
Polysiphonia lanosa (L.) Tandy
P. nigrescens (Huds.) Grev.
P. novae-angliae Taylor
P. urceolata (Lightfoot) Grev.
Porphyra umbilicalis (L.) J. Ag.
Ptilota serrata Kütz.
Rhodocorton purpureum (Lightfoot) Rosenv.
Rhodymenia palmata (L.) Grev.

Chrysophycophyta

Apistonema — like plants
Ruttnera sp. (?*maritima* (Anand) Parke)
Urococcus foslieanus Hansgr.
Vaucheria compacta (Collins) Collins

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PHRAGMITES COMMUNIS IN SOUTH CAROLINA

Phragmites communis Trinius, the tall reed, is a coarse rhizomatous perennial reed forming extensive colonies in open marshy habitats in almost every state of the eastern United States. It occurs sporadically in the southeastern states but has not been previously recorded in South Carolina or Georgia (Radford *et al.*, 1968). It does occur sporadically in North Carolina, favoring a few of the northeastern and southeastern counties.

A large colony of *Phragmites* was discovered by the author in Georgetown County, South Carolina, covering an area of several hundred square meters. The colony is located approximately 100 meters west of the Waccamaw River (at high tide) and 125 meters north of Route 17 South. Vouchers of immature specimens were collected and are on deposit at the herbarium of the University of South Carolina, Columbia, South Carolina.

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BUTOMACEAE: A NEW FAMILY RECORD FOR NORTH DAKOTA

Butomus umbellatus L., flowering rush, was collected on July 25, 1972, four miles south of Valley City, North Dakota (SE¼ Sec. 9, R58W, T139N). Scattered colonies in flower were found growing in shallow water along the shoreline and on silted gravel bars of the Sheyenne River for a distance of about four miles (*Godfread* 4640, 4882, and 4926, NDA). These stations were revisited in 1973 and 1974 and the colonies were increasing in size.

Butomus umbellatus is a native of Eurasia but has become established along the St. Lawrence River Valley. Herbarium records indicate that the species existed in Quebec in 1916. Rousseau (1966) indicates that *B. umbellatus* and another Eurasian introduction, *Lythrum salicaria* L., purple loosestrife, are common along the shoreline of the St. Lawrence River, appearing to be as much in equilibrium as if in their native habitat. It is interesting to note that *L. salicaria* is also well established along the Sheyenne River near Valley City.

Since its introduction into North America, *Butomus umbellatus* has become established at widely scattered localities. In 1956 it was found in Idaho. It was collected in Wisconsin for the first time in 1957, and it is known from Flathead County, Montana (Hahn, 1973). In 1972 it was reported from Rice County, Minnesota, while Van Bruggen (1972) reports *B. umbellatus* in South Dakota from Faulk County, 150 miles south of the North Dakota plants along the Sheyenne River. The establishment of *B. umbellatus* in North Dakota is apparently rather recent. Mr. and Mrs. Russell Pederson, who own adjacent farmland, first noticed the plants five or six years ago.

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GERANIUM SIBIRICUM L. (GERANIACEAE) IN WISCONSIN

This species, adventive from Eurasia, has heretofore been reported to extend from New York and Pennsylvania to Illinois (Fernald, Gray's Manual, ed. 8, 1950.). I report here its discovery in Wisconsin, from records in the herbaria at WIS and OSH. The curators of the herbaria at MIL and UWM have kindly informed me that they have no records of the plant from Wisconsin. The four collections listed below from two counties warrant the inclusion of the plant as an element in the Wisconsin flora.

Wisconsin: DANE CO.: large colony along town road close to village of Dane, *H. C. Greene,* 17 Aug. 1954 (WIS); on disturbed sandy peat in grazed area of south Lake Wabesa marsh, *Don Samuelson,* 5 Sept. 1972 (WIS); in shady, damp soil along Elm Drive, U. of Wisconsin-Madison Campus, *Thomas* 002, 3 Sept. 1972 (WIS). COLUMBIA CO.: along a sandy roadside on Chryslaw Road, to the NW. of the junction of State Route 113 and county trunk J, Sect. 19, R7E, T1ON, *Zaudtke* 053, 9 Sept. 1972 (OSH).

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EDITOR'S NOTE TO CONTRIBUTORS

During the past two years the number of manuscripts submitted to Rhodora has increased markedly, resulting in a substantial backlog of papers awaiting review and a lag time approaching twenty-one months between time of receipt and time of publication. The Editorial Committee consider this an unreasonable length of time and wish to return to a schedule allowing publication within approximately one year of receipt.

Rising costs on every hand, among other factors, prevent significant increases in pagination. As in the past, nonethe-less, we welcome scientific papers concerned with systematic botany in the broad sense, and relating directly or indirectly to the plants of the Western Hemisphere. However, floristic notes, range extensions, and descriptions of formae are discouraged unless they are of considerable significance, are included in a broader taxonomic or ecological study, or relate directly to the flora of New England.

Each contribution will be acknowledged on receipt. Notification of acceptance or rejection will follow review of the manuscript by the Editorial Committee, and in some instances outside reviewers. In all cases the content and quality of the contribution will determine its acceptance. Although we will publish each accepted paper as soon after receipt as possible, the final priority of publication remains at the discretion of the editors. Papers submitted by members of the New England Botanical Club may be given priority over papers from non-members.

Manuscripts should be submitted in duplicate, typed and double-spaced throughout. The cost of plates for illustrations, difficult tabular materials, and reprints must be borne by the author or his institution, and will be billed directly to the author. Page charges may be assessed on articles of excessive length or on papers supported by research grant funds.

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DE PLANTIS TOXICARIIS E MUNDO NOVO TROPICALE COMMENTATIONES XII

NOTES ON BIODYNAMIC PIPERACEOUS PLANTS

RICHARD EVANS SCHULTES

Recent field work has served to corroborate the suspicion long held by botanists that the *Piperaceae* represent a family of plants of very basic importance in the ethnopharmacology of primitive societies of the New World tropics. The following notes are offered as a contribution to our growing knowledge of the use of piperaceous species for their variety of biodynamic activity.

Peperomia emarginella (Sw.) C. De Candolle, in DC. Prodr. **16,** pt. 1 (1869) 437.

COLOMBIA: Comisaría del Putumayo, Mocoa and vicinity. December 8, 1942. *R. E. Schultes et C. E. Smith* 3028.

Called in the Ingano language *cungamanda-ambe,* this herb "pounded and mixed with tobacco and urine" is used "to poultice bites of the cungamanda ant".

Peperomia glabella (Sw.) A. Dietrich var. **melanostigma** Dahlstedt, in Kgl. Sv. Vet. Akad. Handl. **33,** pt. 2 (1900) 122.

COLOMBIA: Comisaría del Putumayo, Mocoa and vicinity. Alt. 820 m. "For *mal de ojo*". December 6, 1942. *R. E. Schultes et C. E. Smith* 2059.

This herb is a supposed remedy for conjunctivitis. In the Ingano language of Mocoa, it is known as *tre-gwen* or *gwinan*.

Peperomia serpens (Sw.) Loudon, Hort. Brit. (1830) 13.

COLOMBIA: Comisaría del Putumayo, Río Sucumbios, Santa Rosa. "Remedy for bite of conga ant. Kofán name: *u-nu-sĕ'-hĕ-pa*". April 7-8, 1942. *R. E. Schultes* 3589.

The aromatic leaves and stems of *Peperomia serpens* are employed locally to relieve the irritant sting of the conga ant. In Kofán, the term *sĕ'-hĕ-pa* refers to a medicinal or poisonous plant.

Piper Allenii Trelease, in Ann. Mo. Bot. Gard. 25 (1938) 826.

PANAMA: Provincia del Darién, trail between Pinogana and Yavisa. Altitude about 15 m. March 17, 1937. *P. A. Allen* 270.

Allen reports that the "roots are used by Indians to deaden pain" and the leaves "as a snake bite remedy".

Piper auritum Humboldt, Bonpland et Kunth, Nov. Gen. et Sp. 1 (1815) 54.

EL SALVADOR: Vicinity of San Salvador. Altitude 650-850 m. February 2-7, 1922. *P. C. Standley* 20550.

According to Standley, the juice of the crushed leaves of this highly aromatic species is employed to remove ticks. The shrub is locally called *Santa María*.

Piper Bartlingianum C. De Candolle, in De Candolle Prodr. 16, pt. 1 (1869) 257.

DUTCH GUIANA: Fetikruk. On sandy hills. August 10, 1939. *Geykes sine num.*

The collector reports *Piper Bartlingianum* as an ingredient of "oerali poison" amongst the Wayana Indians.

Geykes sine num. appears to represent the same species as *A. C. Smith* 2826 and 2827 from British Guiana. It is said to be employed as one of the elements of Waiwai Indian arrow poison.

Piper dactylostigmum Yuncker, in Inst. Bot. São Paulo Bol. No. 3, (1966) 35, fig. 29.

BRAZIL: Estado do Amazonas, Manáos and vicinity, Reserva Ducke. "Climber, adpressed to trunk of tree. Leaves and stem rapidly numb the tongue when chewed". April 13, 1972. *R. E. Schultes et W. Rodrígues* 26150.

The rapid, strong and long lasting numbness of the tongue produced when the leaves and stems of this species are chewed is well known to the inhabitants of the forested areas around Manáos. So far as could be ascertained, however, this property does not constitute the basis of any medicinal or other folk use of *Piper dactylostigmum*. Numbing of the tongue and mucous membranes of the mouth, which, though not common, is known for other species of the genus, sometimes leads to local medicinal use. The leaves and twigs of *Piper corcovadensis* (Miq.) DC. and *P. Jaborandi* Vell., for example, are chewed in the region of Rio de Janeiro to relieve toothache because of their strong numbing effect (Mors, W. B. and C. T. Rizini: *Useful plants of Brazil* (1966) 89).

Piper erythroxyloides R. E. Schultes et García-Barriga sp. nov.

Frutex glaber, usque ad 1½ ped. altus, erectus. Rami simplices vel pauce ramificati, internodiis superioribus sat gracilibus elongatisque, subgranulosis, glabris, 4.5-6 cm. longis. Folia membranacea, elliptica, apice acuminata, basi aequilater subrotundata, 14-18 cm. longa, 6-8.5 cm. lata, omnino pinnatim venosa, venis primariis glabris, utrinque 8-10, supra glabra, subtus minute punctulosa et irregulariter albo-squamulosa; petiolo subcarnosulo, usque ad 1 cm. longo, longitudinaliter striato, scobiculato. Pendunculus subcarnosulus, usque ad 1 cm. longus, glabrus vel minutisime albido-papilloso-pilosus, bracteis crassis, suborbicularibus, cupulatisque, plus minusve 1 mm. longis. Drupa carnosa, extus papillosa, conica, 2 mm. in diametro, 1 mm. longa, in stylum crassum, 0.75 mm. longum desinens.

COLOMBIA: Departamento de Santander del Norte, La Motilonia, Río Catatumbo y Río Brandy. Altitude 80 m. "0.5 m. alto, erecto. Amentos verde-oscuros. Al masticar el tallo se le siente un piquante fuerte y luego se duerme la lengua y los labios. Los indios barí (motilones) lo mastican frecuentemente como la coca. Por lo tanto es narcótico". May 24-26, 1965. *Hernando García-Barriga et Gustavo Lozano*-C 18414. TYPUS in Herb. Nac. Colomb.; TYPUS DUPLICATUS in Econ. Herb. Oakes Ames.

Piper erythroxyloides appears to be most closely allied to *P. dariense* C. DC. of northern Colombia and Panama. It differs in various important respects. The leaves of *Piper erythroxyloides* are basally rounded and apically short acuminate, with a blunt tip (not cuneate and long acuminate with a sharp tip); the internodes are not so slender and are somewhat longer; the inflorescence is usually longer, and thicker; the flowers are more congested, not loosely arranged; the style is thicker; and the stigmas are relatively longer. Perhaps the most noticeable difference lies in the shape of the drupe: in *Piper erythroxyloides*, the fruit is conic and rough-papillose, whereas in *P. dariense* it is globose-tetragonous and either smooth or obscurely papillose.

According to García-Barriga and Lozano, the stems of *Piper erythroxyloides* are chewed by the Motilone (Barí) Indians as a kind of narcotic which has local effects in the mouth that resemble those of coca: whence the specific name *erythroxyloides*. Upon mastication, the stems induce a strong burning sensation which is followed by numbness of the tongue and lips.

In addition to this use, the plant is chewed in the belief that it prevents dental caries.

Local Indian names of *Piper erythroxyloides* are *achikaira* and *chanquira*.

It is of interest to note that in February, 1971, Mr. Alfred M. Ajami of Harvard University submitted to the Botanical Museum several internodes of what appear, so far as such

incomplete material can indicate, to represent the same species: *Piper erythroxyloides*. According to Mr. Ajami, the Barí Indians of the central Venezuelan region west of Lake Maracaibo, who chew the internodes as an aphrodisiac, experience a strong analgesic effect in the mouth and conspicuous dilation of the pupils. Inasmuch as the tribe is apparently the same group as the Colombian "Motilones" and the two localities are not distant, the information communicated by Mr. Ajami assumes greater significance. It is hoped that complete botanical specimens from the Venezuelan locality may be forthcoming.

Piper hispidum Swartz, Prodr. Veg. Ind. Occ. (1788) 15.

ECUADOR: Parroquia Concepión, Playa Rica. Altitude 91 m. "Forest near stream; undergrowth. Perennial herb 4 m. high; aments erect. Common". December 6, 1936. *Y. Mexia* 8407.

The collector reports that the leaves of this plant are "crushed in water to kill head lice". It is locally known as *pipilongo*. This collection is the type of *Piper pediculicidum* Trelease.

Piper cf. **interitum** Trelease ex Macbride, in Field Mus. Publ. Bot. **13**, no. 357 (1936) 176.

PERU: Departamento de Loreto, alto Río Purús, Zapote. "Culina Indian name: *tetsi*. Substitute of tobacco snuff. The leaves are dried and reduced into powders. Tree about 10 m. high. Lowland forest". October 15, 1968. *Laurent Rivier* 21.

This interesting report of the preparation of a snuff from the leaves of a species of *Piper* — a snuff used as a "substitute" for tobacco — provides a significant addition to our growing understanding of plants employed in South America in the preparation of powders for inhalation. The number of species utilized is much larger than has been suspected, and, in this case, the indication of psychoactive constituents — probably essential oils — adds to the ethnopharmacological interest of the report.

Piper sp.

BRAZIL: Estado do Amazonas, Rio Livramento, Humaytá, near Livramento. October 12-November 6, 1934. *B. A. Krukoff* 6972.

The stem of this vine-like species of *Piper*, according to the collector's notes, contains "a substance producing local anaesthesis". The plant is employed locally by the Indians "to cure toothache" and is called *cipó de dor dente* ("toothache vine").

Pothomorphe umbellata (L.) Miquel, Comm. Phyt. (1840) 36.

COLOMBIA: Comisaría del Putumayo, Río Guamués, San Antonio. Secondary growth near path. "Kofán Indian name: *a-nama-he sĕ'-hĕ-pa*. Curare, used alone or mixed; for monkeys and wild pigs (saquita). Bark of lower stem and root is scraped, then boiled. Herb 5-6 feet". September 5, 1966, *H. V. Pinkley* 421. Same locality. February 18, 1966, *Pinkley* 119.

The preparation of arrow poisons amongst the Kofán Indians of the border region of Colombia and Ecuador is ethnobotanically extremely complex. Although piperaceous plants are known to be employed as ingredients of arrow-poisons over a wide area in tropical America (Hegnauer, R.: *Chemotaxonomie der Pflanzen* 5:321. 1969), Pinkley's report of the utilization of *Pothomorphe umbellata* "alone or mixed" assumes special significance. Most, if not all, of the piperaceous species employed in these preparations are not known to have curare constituents, and their use as additives may be based on superstition or symbolism. If a species be utilized "alone" — that is, as the only ingredient in a curare — it must have a biodynamically active constituent.

CHROMOSOME COUNTS OF COMPOSITAE FROM THE UNITED STATES, MEXICO, AND GUATEMALA[1]

DAVID J. KEIL AND TOD F. STUESSY

Chromosome numbers can be extremely useful in systematic studies, particularly for helping to reveal evolutionary relationships. For the past fifteen years numerous chromosome reports from plants have been published, especially in the Compositae, and these counts have been compiled in several major sources (Darlington & Wylie, 1955; Cave, 1958-65; Ornduff, 1967-69; Fedorov, 1969; Moore, 1970-72). However, a rapid glance through these references indicates not only that many species never have been counted, but also that many taxa are known only from a single plant in one population. In view of the common occurrence of euploid and aneuploid races in plants as illustrated by several detailed investigations (e.g., Lewis, 1962, 1970; Stuessy, 1971a), it is desirable to have several to many counts from each species before accurate judgments can be made regarding evolutionary relationships (Stuessy, 1971b; Kovanda, 1972; Strother, 1972). The present paper helps to remedy these deficiencies in the Compositae by: (1) reporting first chromosome counts for several genera, species, and varieties; and (2) reporting additional populational chromosome counts for taxa documented previously.

MATERIALS AND PROCEDURES

The meiotic chromosomal material for this study was collected during the past several years by the senior and junior authors on various field excursions. Immature capitula were killed and fixed in modified Carnoy's fluid (4 chloroform: 3 absolute alcohol: 1 glacial acetic acid) and refrigerated in the laboratory until later prepared by con-

[1]Publication No. 843 from the Department of Botany, The Ohio State University, Columbus.

ventional acetocarmine squash techniques. Voucher specimens collected by Keil and assistants are on deposit in the herbarium of The Ohio State University (OS); vouchers collected by Stuessy are in the herbarium of the University of Texas at Austin (TEX).

RESULTS

The chromosome counts obtained in the present study are listed in Table 1. First counts are reported for two genera, 16 additional species, and one variety; 112 additional counts are for taxa counted previously, seven of which are new numbers. The first counts for genera are from *Epaltes* Cass. ($n = 10$) and *Tricarpha* Longpre ($n = 8$), and first counts for species are in *Bidens* L., *Calea* L., *Guardiola* Cerv. ex H. & B., *Machaeranthera* Nees, *Melampodium* L., *Otopappus* Benth., *Sclerocarpus* Jacq., *Senecio* L., *Sigesbeckia* L., *Simsia* Pers., *Spilanthes* Jacq., *Tridax* L., and *Zaluzania* Pers.

DISCUSSION

Because many of the counts presented here corroborate previous chromosomal reports, the discussions are restricted either to first counts or to new reports for genera, species, or varieties. The order of commentary will follow the sequence of tribes in the classification of Hoffmann (1890-94), which is the same as that used in Table 1. References for statements regarding the range of chromosomal variation within genera will not be given; documentation for these counts comes from the several major sources cited in the introduction to this paper.

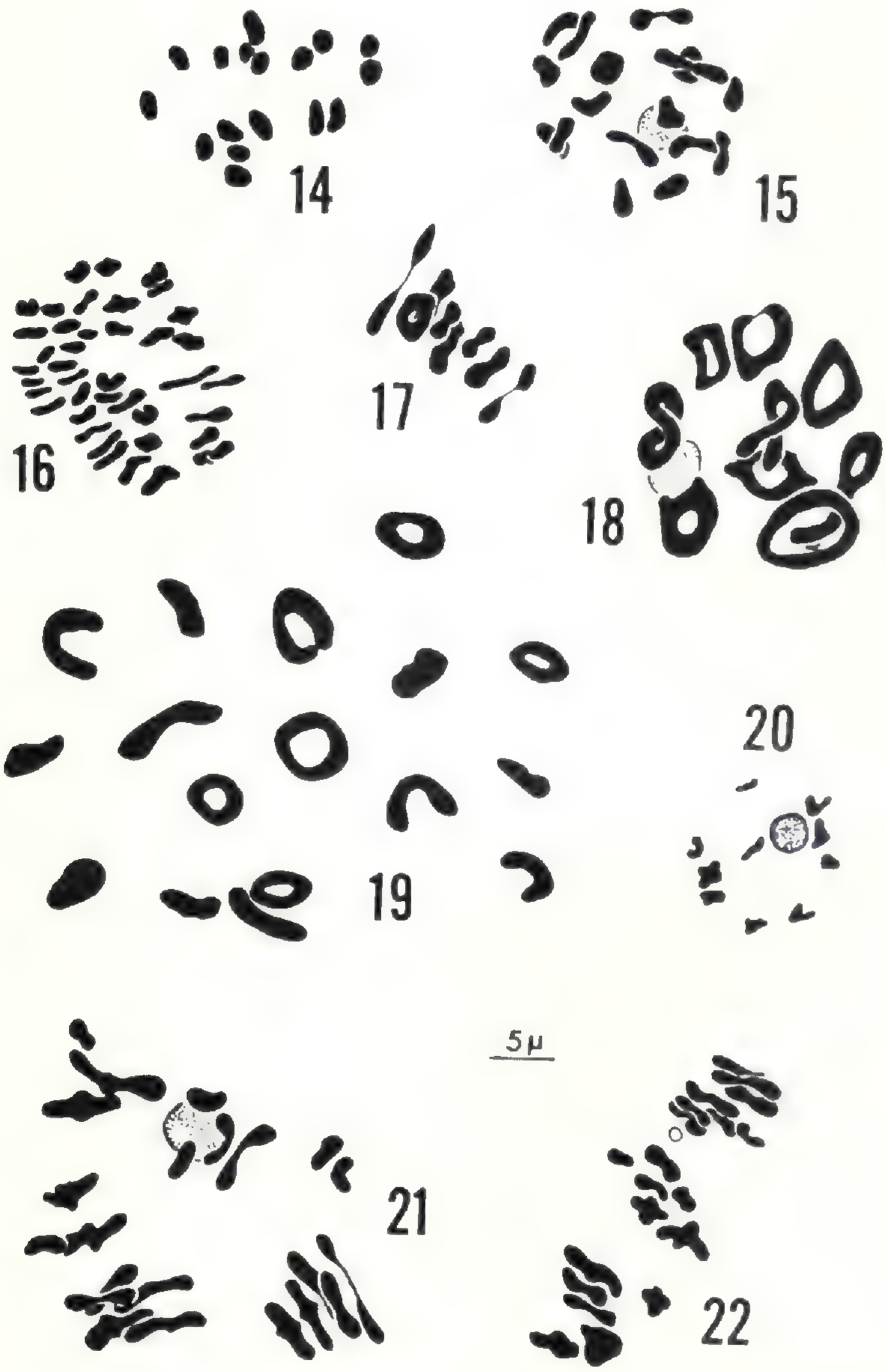
EUPATORIEAE. Counts for three herbaceous species of *Stevia* Cav. represent new reports. *Stevia elatior* H.B.K. is cited here as $n = 12_{II}$ & 12_{I} (Fig. 1), whereas the two previously recorded numbers have been $n = 34_{I}$ (Powell & Turner, 1963) and $n = 33_{I}$ (Grashoff, Bierner, & Northington, 1972). Our count for *Stevia origanoides* H.B.K.,

reported here as $n = 11$ (Fig. 2), is the first for this taxon at what appears to be the diploid level; the previous counts were $n = 34_{\text{I}}$ and $n =$ ca. $43 \pm 1_{\text{I}}$ (Grashoff *et al.*, 1972). *Stevia plummerae* A. Gray var. *durangensis* Robins. has been reported before only once by Grashoff *et al.* (1972) as $n =$ ca. 17, but our count is $n = 44_{\text{I}}$ (Fig. 3). As pointed out by Grashoff *et al.* (1972), it is common to find varying meiotic chromosomal associations and numbers in species that have apomictic races, as are present in these three taxa. It is not surprising, therefore, that our reported counts add to this chromosomal diversity.

ASTEREAE. Several previous counts have been reported for *Erigeron karwinskianus* DC.: $2n = 32$ (Carano, 1924; Battaglia, 1950); $2n = 36$ (Fagerlind, 1947; Larsen, 1953, 1954; Kliphuis & Wieffering, 1972); $n = 9$ and $n = 27_{\text{I}}$ (Turner, Ellison, & King, 1961); and $n =$ ca. 27 (Turner, Powell, & King, 1962). Considering the variation in chromosome number that has been documented previously in this species, as well as our new report of $n = 5_{\text{II}}$ & 17_{I} (Fig. 4), it is likely that *E. karwinskianus* is apomictic through at least part of its range from Mexico to northern South America (Solbrig, 1962). It is interesting that our count comes from a population very near the locality cited by Turner *et al.* (1961) for their counts of $n = 9$ and $n = 27_{\text{I}}$.

Machaeranthera coulteri (A. Gray) Turner & Horne (as *Psilactis coulteri* A. Gray) was reported as $n = 5$ by Solbrig, Anderson, Kyhos, Raven, and Rüdenberg (1964). However, based on the recent revision of sect. *Psilactis* of *Machaeranthera* by Turner and Horne (1964), the geographic location of the voucher for the count seems more appropriate for *M. arida* Turner & Horne than for *M. coulteri*. The latter species, as recently interpreted, is known only from the vicinity of Guaymas, Sonora, where our voucher was collected. Our first count of $n = 5$ (Fig. 5) for *Machaeranthera coulteri* is particularly interesting because in the previously mentioned revision of sect. *Psilactis* of the genus (Turner & Horne, 1964; cf. their

Figs. 1-22. Camera lucida drawings of meiotic chromosomes of species of Compositae. Diplotene, Fig. 18; diakinesis, Figs. 5, 7-10, 12, 15, 19-21; metaphase I, Figs. 1, 3, 4, 6, 11, 14, 16, 17; metaphase II, Figs. 2 (one half of cell shown), 13. All figures same scale. Bivalents black, univalents white. KC = Keil & Canne, KM = Keil & McGill, K = Keil. Fig. 1, *Stevia elatior*, *K* 9396, $n = 12_{II}$ & 12_{I}; Fig. 2, *Stevia origanoides*, *KC* 8884, $n = 11$; Fig. 3, *Stevia plummerae* var. *durangensis*, *KC* 8927-1, $n = 44_{I}$; Fig. 4, *Erigeron karwinskianus*, *KC* 9178, $n = 5_{II}$ & 17_{I}; Fig. 5, *Machaeranthera coulteri*, *KC* 8637, $n = 5$; Fig. 6, *Epaltes mexicana*, *KC* 9211, $n = 10$; Fig. 7, *Bidens*



riparia var. *refracta*, *KC* 8710, $n = 12$; Fig. 8, *Guardiola platyphylla*, *KM* 8558, $n = 12$; Fig. 9, *Melampodium appendiculatum*, *KC* 8706A, $n = 10$; Fig. 10, *Otopappus imbricatus*, *KC* 9112, $n = 16$; Fig. 11, *Parthenium incanum*, *KM* 7765A, $n = 18_{II}$ & 18_{I}; Fig. 12, *Sclerocarpus spatulatus*, *KC* 8671A, $n = 11$; Fig. 13, *Sigesbeckia jorullensis*, *KC* 8902, $n = 30$; Fig. 14, *Simsia eurylepis*, *KC* 9231, $n = 17$; Fig. 15, *Simsia grayi*, *KC* 9081, $n = 17$; Fig. 16, *Spilanthes phaneractis*, *KC* 9035, $n = 41$; Fig. 17, *Tricarpha durangensis*, *KC* 8860A, $n = 8$; Fig. 18, *Tridax tenuifolia* var. *microcephala*, *KC* 8808, $n = 9$; Fig. 19, *Zaluzania grayana*, *KM* 8379A, $n = 17$; Fig. 20, *Schkuhria pinnata* var. *guatemalensis*, *K* 9402A, $n = 10$; Fig. 21, *Senecio runcinatus*, *KC* 9192, $n = 22$; Fig. 22, *Pinaropappus roseus*, *KC* 9177, $n = 20_{II}$ & 1_{I}.

Fig. 3), *M. coulteri* on morphological grounds was placed in the $x = 5$ cytophyletic group along with *M. arida* and *M. crispa* (Brandg.) Turner & Horne, both known chromosomally as $n = 5$. More recently *M. arizonica* Jackson & R. R. Johnson and *M. parviflora* A. Gray have been added to this group and both species have been counted as $n = 5$ (Jackson & Johnson, 1967). This first chromosomal report for *M. coulteri* substantiates its phyletic association with these other species. All other taxa in sect. *Psilactis* are known chromosomally as either $n = 4$ or $n = 9$ (Turner & Horne, 1964).

INULEAE. The first report for *Epaltes* (*E. mexicana*), $n = 10$ (Fig. 6), is in keeping with its present subtribal disposition in the Plucheinae. Of the related genera of the same subtribe (Hoffmann, 1890-94) that are known chromosomally (*Blumea* DC., *Pluchea* Cass., *Pterigeron* (DC.) Benth., *Pterocaulon* Ell., *Sphaeranthus* L., and *Tessaria* Ruiz & Pav.), all are based on $x = 10$ except *Blumea* which appears multibasic with $x = 9$, 10, and 11. On morphological and geographical grounds, in our opinion, *Epaltes mexicana* Less. is quite similar to some species of *Pluchea*, the former differing mainly in its smaller heads and flowers and in its epappose achenes. As emphasized by Bentham (1873) and Godfrey (1952), the generic boundaries in the Plucheinae are not well defined and perhaps should be re-evaluated.

HELIANTHEAE. *Bidens riparia* is reported for the first time as $n = 12$ (Fig. 7) in a genus that has most frequently counted numbers of $n = 12$, 24, and 36 (clearly based on $x = 12$).

The first count for *Calea zacatechichi* Schlecht., $n =$ ca. 19, is in keeping with previous reports for other species of the genus ($n = 9$, 16, 18, 19, 24, 32). According to the most recent revision of the Mexican and Central American taxa (Robinson & Greenman, 1896), *C. zacatechichi* is most closely related to *C. nelsonii* Robins. & Greenm. which has been counted as $n =$ ca. 18 (Turner *et al.*, 1962). The

morphological and chromosomal heterogeneity within *Calea* and the absence of a recent revision of the entire genus suggest that a thorough modern study is much needed.

Guardiola, a genus of about ten species, has been placed traditionally in the subtribe Melampodiinae (Hoffmann, 1890-94). However, recent studies by the junior author suggest that on morphological and cytological evidence it belongs more properly in the Coreopsidinae (Stuessy, 1973). Our first count of $n = 12$ (Fig. 8) for *G. platyphylla* A. Gray is consistent with the recent reports of $n = 12$ for both *G. tulocarpus* A. Gray (Grashoff *et al.*, 1972) and *G. mexicana* H. & B. (Solbrig, Kyhos, Powell, & Raven, 1972),[2] and with the base number of $x = 12$ for several other members of this subtribe.[3]

The count of $n = 10$ (Fig. 9) is a first report for *Melampodium appendiculatum* Robins. In a recent revision of the genus (Stuessy, 1972) this species is placed in series *Cupulata* of sect. *Melampodium;* three other related species (*M. cupulatum* A. Gray, *M. rosei* Robins., and *M. tenellum* Hook. & Arn.) also are known chromosomally as $n = 10$ (Stuessy, 1971b). The addition of this new count increases the number of species surveyed within the genus to 27 out of 37.

The first generic report for *Otopappus* (*O. scaber* S. F. Blake) has been published recently by Solbrig *et al.* (1972) as $n = 16$. Our first report for *O. imbricatus* (Sch.-Bip.) S. F. Blake of $n = 16$ (Fig. 10) confirms this chromosomal level for the genus. The related genera *Salmea* DC. and *Notoptera* Urb. (Blake, 1915) are known respectively as $n = 18 + 2$ frag. (Turner *et al.*, 1962) and $n =$ ca. 15 & 16 (Turner *et al.*, 1962; Turner & King, 1964), although very few taxa have been examined from each.

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[2]The count published by Solbrig *et al.* was listed for *G. atriplicifolia* A. Gray, but in the most recent published revision of the genus (Robinson, 1899) this epithet is regarded as synonymous with *G. mexicana.*

[3](e.g., *Bidens* L., *Coreopsis* L., *Cosmos* Cav., *Glossocardia* Cass., *Thelesperma* Less.)

Parthenium L., and particularly *P. argentatum* A. Gray, has been studied extensively for many years (cf. Hammond & Polhamus, 1965), including a comprehensive revision by Rollins (1950). *Parthenium incanum* H.B.K. has been reported previously as having a polyploid series of $n = 18$, 27, 36, and 45, but our new count is $n = 18_{II}$ & 18_{I} (Fig. 11). This interploid number could represent the product of hybridization between *P. incanum* and other species of the genus that grow in the vicinity, such as *P. argentatum*, but our voucher specimens show no morphological indication of such intergradation. Alternatively, the meiotic configuration could indicate a hybrid between $n = 18$ and $n = 36$ cytotypes of the same species. The plants under consideration also could be apomictic, a condition that is known to occur in populations in the northern range of *P. incanum* (Rollins, 1950) where our material was collected.

The count of $n = 11$ (Fig. 12) for *Sclerocarpus spatulatus* Rose is consistent with previously reported numbers of $n = 11$, 12, 14, and 18 in the genus as recently defined by Feddema (1971). The closely related genus, *Aldama* LaLlave & Lex., is known chromosomally as $n = 17$ (Turner *et al.*, 1962; Powell & Cuatrecasas, 1970; Feddema, 1971).

Sigesbeckia L. of the subtribe Helianthinae is a small genus of less than ten species. It is worthwhile to mention that a close morphological resemblance exists with *Trigonospermum* Less. (McVaugh & Anderson, 1972; Stuessy, 1973) and perhaps also with *Rumfordia* DC., the former of the subtribe Melampodiinae and the latter of the Helianthinae. Our count of $n = 15$ is a first report for *S. agrestis* Poepp. & Endl. All but two other reports in the genus [$n = 12$ (Subramanyam & Kamble, 1967) and $2n = 20$ (Hsu, 1967) for *S. orientalis* L.] have been either $n = 15$ or $n = 30$. Infraspecific euploidy is known to occur in *S. orientalis* (Mehra, Gill, Mehta, & Sidhu, 1965) and it is now documented for *S. jorullensis* H.B.K. by our counts of $n = 15$ and 30 (Fig. 13). Only one count of $n = 15$ (Solbrig *et al.*, 1972) has been recorded previously for this species.

Of the approximately 35 species of *Simsia* recognized by various authors (Blake, 1913, 1917, 1928; Cuatrecasas, 1954; Robinson & Brettell, 1972), ten have been counted from morphologically diverse parts of the genus, and all counts have been $n = 17$. Our first counts of $n = 17$ (Figs. 14 & 15) for *S. eurylepis* S. F. Blake and *S. grayi* Sch.-Bip. ex S. F. Blake emphasize the chromosomal uniformity within the genus.

Spilanthes with approximately 60 species (Moore, 1907) is a taxonomically complex genus much in need of revisionary attention. It appears to belong in the subtribe Galinsoginae rather than in the Helianthinae as traditionally placed (Hoffmann, 1890-94). Chromosomally the situation also is complex. Even though only six species have been counted, four base numbers, $x = 7$, 12, 13, and 16, are present. Our first report of $n =$ ca. 45 for *S. ocymifolia* (Lam.) A. H. Moore adds another chromosomal level to the already chromosomally diverse sect. "Salivaria" (= sect. *Spilanthes*) known with $n = 7$, 12, 16, and 26. All previous reports for sect. *Acmella* (Rich.) DC. have been clearly based on $x = 13$ (only $n = 13$ and $n = 26$ counts reported). Our new report of $n = 41$ (Fig. 16) for *S. phaneractis* (Greenm.) A. H. Moore increases the chromosomal diversity of this section as well.

Tricarpha is a genus of two species recently described by Longpre (1970). Our first count for the genus (from *T. durangensis* Longpre) of $n = 8$ (Fig. 17) substantiates its presumptive close relationship to *Sabazia* Cass. ($n = 4$, 8, and 16) and *Selloa* Kunth ($n = 8$) as mentioned by Longpre (1970). The problem of generic delimitation in the subtribe Galinsoginae, involving *Tricarpha*, *Sabazia* and *Selloa* as well as *Galinsoga* Ruiz & Pavon, *Stenocarpha* S. F. Blake, *Tridax* and *Jaegeria* Kunth, is much in need of further study, despite the appearance in recent years of several excellent revisions (Powell, 1965; Turner, 1965; Torres, 1968; Longpre, 1970). Part of the difficulty in sorting out the proper affinities of all the taxa in the Galinsoginae is that previous workers have been working from the

perspective primarily of a single genus and not from a perspicacious overview of many of the genera within the subtribe. An added difficulty is the absence of a recent revision of *Galinsoga* (most recent treatment that of Robinson, 1894), the understanding of which clearly is central to sorting out these generic relationships.

Our first report for *Tridax tenuifolia* Rose, $n = 9$ (Fig. 18), fits well with the established base number of $x = 9$ for sect. *Tridax* to which *T. tenuifolia* belongs (Powell, 1965).

Of the 14 species of *Zaluzania* recognized by Sharp (1935), six have been counted with definite numbers of $n = 16$ and 18. Our first report, $n = 17$ (Fig. 19), for *Z. grayana* Robins. & Greenm. firmly establishes this as a new chromosomal level for the genus (a previous count of $n = 17 \pm 1$ for *Z. montagnaefolia* Sch.-Bip. was reported by Powell and Turner, 1963).

HELENIEAE. *Schkuhria pinnata* (Lam.) Cabrera has been counted before as $2n = 20$ (Covas and Schnack, 1946), and var. *virgata* (LaLlave) Heiser of the same species has been reported as $n =$ ca. 20 (Turner *et al.*, 1962). Recently McVaugh (1972) transferred *S. anthemoidea* (DC.) Coult. var. *guatemalensis* (Rydb.) Heiser to *S. pinnata*, and our counts of $n = 10$ (Fig. 20) for this taxon are the first reports. A count of $n = 11$ (Table 1) was obtained from material tentatively identified as *S. anthemoidea*. However, our voucher specimen differs from the characters of this species as delimited by Heiser (1945) in having more numerous disc florets and large ray florets, as in *S. schkuhrioides* (Link & Otto) Thellung in Fedde. In pappus structure, though, our plants are much more similar to *S. anthemoidea* than to *S. schkuhrioides*. This collection may represent a previously undescribed taxon.

SENECIONEAE. Our first reports of $n =$ ca. 30 for *Senecio hartwegii* Benth. and $n = 22$ (Fig. 21) for *S. runcinatus* Less. are consistent with counts reported previously for other taxa of the genus. Thirty-three species of *Senecio*

have been reported as $n = 30$ and six are known with $n = 22$. Although the genus is based either on $x = 5$ (Barkley, 1962) or $x = 10$ (Ornduff, Raven, Kyhos, & Kruckeberg, 1963; Ornduff, Mosquin, Kyhos, & Raven, 1967), the diversity of haploid numbers is great, representing 30 different chromosomal levels from $n = 5$ to $n =$ ca. 92.

CICHORIEAE. The small genus *Pinaropappus* Less. has been counted from only one species, *P. roseus* Less., and the reported counts are $n = 9$ and 18 (Darlington & Wylie, 1955; Turner *et al.*, 1961; Powell & Turner, 1963; Powell & Sikes, 1970). Our present count of $n = 20_{II}$ & 1_{I} (Fig. 22) is a new report for this taxon. The meiotic configurations of cells in our preparation were irregular with bridges, lagging chromosomes, and varying numbers of univalents.

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Table 1. Chromosome counts of Compositae from the United States, Mexico, and Guatemala.

Taxon	Locality and voucher	Chromosome number (n)[a]
EUPATORIEAE		
Ageratum corymbosum Zuccag.	MEXICO: **Sinaloa:** 16.4 mi. NE. of Santa Lucia, *KC* 8859.[b]	10
Brickellia coulteri A. Gray	MEXICO: **Durango:** 8.8 mi. S. of Nazareno, *KM* 8025.[c]	9
Stevia anadenotricha (Robins.) Grashoff	MEXICO: **Durango:** 12.7 mi. SW. of La Ciudad, *KC* 8883.	12
†*Stevia elatior* H.B.K.	GUATEMALA: **Guatemala:** 12.8 km. E. of Cd. Guatemala, *K* 9396.[d]	12_{II} & 12_{I} (Fig. 1)
†*Stevia origanoides* H.B.K.	MEXICO: **Durango:** 12.7 mi. SW. of La Ciudad, *KC* 8884.	11 (Fig. 2)
†*Stevia plummerae* A. Gray var. *durangensis* Robins.	MEXICO: **Durango:** 9.7 mi. NE. of La Ciudad, *KC* 8927-1.	44_{I} (Fig. 3)
Stevia salicifolia Cav. var. *salicifolia*	MEXICO: **Chihuahua:** 9.5 mi. W. of General Triás, *KM* 8288.	12
ASTEREAE		
Aphanostephus arizonicus A. Gray	MEXICO: **Chihuahua:** 10.4 mi. S. of Cd. Chihuahua, *KM* 8263A.	4
Aphanostephus ramosissimus DC.	MEXICO: **Chihuahua:** 24 mi. N. of Cd. Chihuahua, *S* 1097.[e]	4
Aster exilis Ell.	MEXICO: **Sinaloa:** 11 mi. NE. of Santa Lucia, *KC* 8850A.	5

Aster spinosus Benth.	MEXICO: **Coahuila:** 5.5 mi. E. of Nazareno, *KM* 8010.	**9**
Baccharis glutinosa Pers.	MEXICO: **Sonora:** Arroyo Cuchujaqui on Álamos-Guirocoba rd., *KC* 8675.	**9**
Conyza sophiaefolia H.B.K.	MEXICO: **Sinaloa:** 11 mi. NE. of Santa Lucia, *KC* 8848.	**9**
Erigeron divergens Torr. & A. Gray	MEXICO: **Chihuahua:** 39 mi. W. of Cd. Chihuahua, *S* 1025.	9
†*Erigeron karwinskianus* DC.	MEXICO: **Veracruz:** 11.1 mi. E. of Puebla-Veracruz boundary on Rte. 150-D, *KC* 9178.	5_{II} & 17_{I} (Fig. 4)
Grindelia sp. nov.[f]	MEXICO: **Chihuahua:** 2 mi. S. of Cuauhtémoc, *S* 1041.	6
***Machaeranthera coulteri* (A. Gray) Turner & Horne	MEXICO: **Sonora:** ca. 15 mi. E. of Guaymas, *KC* 8637.	5 (Fig. 5)
Machaeranthera pinnatifida (Hook.) Shinners	MEXICO: **Chihuahua:** ca. 2 mi. W. of Parral, *S* 993.	4
Machaeranthera scabrella (Greene) Shinners	MEXICO: **Coahuila:** 110 mi. S. of Piedras Negras, *KM* 7855; 14.9 mi. N. of Rancho Acatita, *KM* 8079A. UNITED STATES: **Texas:** PRESIDIO CO.: 15.2 mi. W. of Lajitas, *KM* 7787.	4
Xanthocephalum sericocarpum A. Gray	MEXICO: **Chihuahua:** 2 mi. S. of Cuauhtémoc, *S* 1044.	4
INULEAE		
****Epaltes mexicana* Less.	MEXICO: **Veracruz:** 33.5 mi. E. of Poza Rica, *KC* 9211.	10 (Fig. 6)

HELIANTHEAE		
Ambrosia artemisiifolia L.	UNITED STATES: **Illinois:** LAKE CO.: Lake Forest College campus, *S* 1132.	18
Ambrosia psilostachya DC.	MEXICO: **Tamaulipas:** ca. 2 mi. SE. of Reynosa, *S* 774 (ca. 18). UNITED STATES: **Texas:** KINNEY CO.: 42 mi. NW. of Eagle Pass, *S* 877a, b.	18
Ambrosia psilostachya DC.	MEXICO: **Chihuahua:** 7 mi. NW. of Cuauhtémoc, *S* 1062a.	ca. 36
Ambrosia psilostachya DC.	UNITED STATES: **Texas:** BRAZORIA CO.: 12 mi. NE. of Freeport, *Turner* 5747 (ca. 54); GALVESTON CO.: 60 S. Theresa, Galveston, *Miller* s.n.	54
Baltimore recta L.	GUATEMALA: **Santa Rosa:** 3.5 km. NW. of Culiapa, *K* 9403.	15
Bidens pilosa L. var. *minor* (Blume) Sherff f. *minor*	MEXICO: **Guerrero:** 10 mi. S. of Chilpancingo, *KC* 9126.	12
Bidens pilosa L. var. *radiata* Sch.-Bip. in Webb & Berth. f. *dondiaefolia* (Less.) Sherff	MEXICO: **Distrito Federal:** 17.7 mi. W. of D.F.-Puebla boundary on Rte. 190-D, *KC* 9164.	12
Bidens pilosa L. var. *radiata* Sch.-Bip. in Webb & Berth. f. *radiata*	MEXICO: **Chihuahua:** 15.5 mi. W. of Santa Lucia, *KM* 8304.	12
***Bidens riparia* H.B.K. var. *refracta* (Brandg.) O.E. Schulz	MEXICO: **Sonora:** 5.5 mi. E. of Arroyo Cuchujaqui on Álamos-Milpillas rd., *KC* 8710.	12 (Fig. 7)
Calea urticifolia (Mill.) DC.	GUATEMALA: **Guatemala:** 6.8 km. NE. of Amatitla, *K* 9430.	19
***Calea zacatechichi* Schlecht.	MEXICO: **Jalisco:** 1.2 mi. NW. of Magdalena airport, *KC* 9008.	ca. 19

Chrysanthellum mexicanum Greenm.	MEXICO: **Nayarit:** ca. 18 mi. SE. of Tepic, *KC* 8965.	8
Cosmos linearifolius (Sch.-Bip.) Hemsl. var. *linearifolius*	MEXICO: **Durango:** 10.5 mi. SW. of La Ciudad, *KC* 8892.	23
Cosmos parviflorus (Jacq.) Pers.	MEXICO: **Sinaloa:** 16.4 mi. NE. of Santa Lucia, *KC* 8858.	12
Dicranocarpus parviflorus A. Gray	MEXICO: **Coahuila:** jctn. Rte. 40 & rd. to San Pedro, *KM* 7991.	10
Eclipta alba (L.) Hassk.	MEXICO: **Sinaloa:** 14.5 mi. S. of Sinaloa-Sonora boundary on Rte. 15, *KC* 8736.	11
Flaveria trinervia (Spreng.) C. Mohr.	MEXICO: **Jalisco:** Ocotlán, *KC* 9036.	18
Guardiola mexicana H. & B.	MEXICO: **Guerrero:** 7 mi. NE. of Taxco, *KC* 9107.	12_{II} & frag.
***Guardiola platyphylla* A. Gray	UNITED STATES: **Arizona:** COCHISE CO.: ca. 10.5 mi. W. of Coronado Natl. Mem. headqtrs., *KM* 8558.	12 (Fig. 8)
Helianthus laciniatus A. Gray	MEXICO: **Durango:** 2 mi. NW. of Bermejillo, *S* 940.	17
Heterosperma pinnatum Cav.	MEXICO: **Sinaloa:** 3.8 mi. SW. of Santa Lucia, *KC* 8833.	25
Jaegeria hirta (Lag.) Less.	GUATEMALA: **Alta Verapaz:** 4 mi. NE. of San Pedro Carchá, *S* 596. MEXICO: **Durango:** 8.3 mi. SW. of La Ciudad, *KC* 8903C, 8909; 4.8 mi. SW. of La Ciudad, *KC* 8916; 15.6 mi. NE. of La Ciudad. *KC* 8929. **Michoacán:** 54 mi. E. of Zamora, *KC* 9060. **Puebla:** Teteles, *S* 498. **Sinaloa:** 3.8 mi. SW. of Santa Lucia, *KC* 8832A.	18

Jaegeria macrocephala Less.	MEXICO: **Michoacán:** 26 mi. S. of Pátzcuaro, *S* 686. **Veracruz:** 8 mi. N. of Jalapa, *S* 491, 492.	18
***Melampodium appendiculatum* Robins.	MEXICO: **Sonora:** 0.3 mi. N. of Arroyo Cuchujaqui on Álamos-Guirocoba rd., *KC* 8672A; 4.7 mi. E. of Arroyo Cuchujaqui on Álamos-Milpillas rd., *KC* 8706A.	10 (Fig. 9)
Melampodium cupulatum A. Gray	MEXICO: **Sinaloa:** 27.3 mi. S. of Sinaloa-Sonora boundary on Rte. 15, *KC* 8742A.	10
Melampodium divaricatum (Rich. in Pers.) DC.	MEXICO: **Sinaloa:** 7.7 mi. SE. of Escuinapa, *KC* 8950.	12
Melampodium perfoliatum (Cav.) H.B.K.	MEXICO: **Jalisco:** Ocotlán, *KC* 9034.	11
Melanthera aspera (Jacq.) Small var. *aspera*	GUATEMALA: **Suchitepequez:** 4.5 km. E. of puente Madre Vieja, *K* 9436A.	15
Milleria quinqueflora L.	MEXICO: **Nayarit:** ca. 18 mi. SE. of Tepic, *KC* 8960-1. **Sinaloa:** 0.4 mi. SW. of Santa Lucia, *KC* 8835. **Sonora:** 4.7 mi. E. of Arroyo Cuchujaqui on Álamos-Milpillas rd., *KC* 8708.	15
***Otopappus imbricatus* (Sch.-Bip.) S. F. Blake	MEXICO: **Guerrero:** 2.6 mi. S. of Taxco, *KC* 9112.	16 (Fig. 10)
Parthenium confertum A. Gray var. *lyratum* (A. Gray) Rollins	UNITED STATES: **Texas:** PRESIDIO CO.: 10 mi. S. of Shafter, *KM* 7764.	36
†*Parthenium incanum* H.B.K.	UNITED STATES: **Texas:** PRESIDIO CO.: 10 mi. S. of Shafter, *KM* 7765A, B.	18_{II} & 18_{I} (Fig. 11)
Philactis nelsonii (Greenm.) S. F. Blake	MEXICO: **Chiapas:** 11 mi. N. of Arriaga, *S* 630.	28
Sanvitalia procumbens Lam.	MEXICO: **México:** 1.1 mi. N. of Ixtapán de la Sal, *KC* 9093A.	8

***Sclerocarpus spatulatus* Rose	MEXICO: **Sonora:** 2.4 mi. S. of Álamos, *KC* 8671A.	11 (Fig. 12)
Sclerocarpus sessilifolius Greenm.	MEXICO: **Nayarit:** ca. 18 mi. SE. of Tepic, *KC* 8963-1.	14
***Sigesbeckia agrestis* Poepp. & Endl.	GUATEMALA: **Alta Verapaz:** 4 mi. NE. of San Pedro Carchá, *S* 595.	15
Sigesbeckia jorullensis H.B.K.	MEXICO: **México:** 2 mi. E. of Cuajimalpa, *S* 672, 673.	15
†*Sigesbeckia jorullensis* H.B.K.	MEXICO: **Durango:** 9.7 mi. SW. of La Ciudad, *KC* 8902.	30 (Fig. 13)
***Simsia eurylepis* S. F. Blake	MEXICO: **Veracruz:** 10.8 mi. SW. of Panuco, *KC* 9231.	17 (Fig. 14)
***Simsia grayi* Sch.-Bip. ex S. F. Blake	MEXICO: **Michoacán:** 1.8 mi. S. of Tuxpan, *KC* 9081.	17 (Fig. 15)
Spilanthes americana (Mut.) Hieron. var. *parvula* (Robins.) A. H. Moore	MEXICO: **Veracruz:** 5 mi. N. of Jalapa, *KC* 9188.	ca. 24
***Spilanthes ocymifolia* (Lam.) A. H. Moore	GUATEMALA: **Guatemala:** 6.8 km. NE. of Amatitla, *K* 9429A.	ca. 45
***Spilanthes phaneractis* (Greenm.) A. H. Moore	MEXICO: **Jalisco:** Ocotlán, *KC* 9035.	41 (Fig. 16)
Tithonia calva Sch.-Bip.	MEXICO: **Sinaloa:** 6.8 mi. NE. of Santa Lucia, *KC* 8845.	17
Tragoceros americanus (Mill.) S. F. Blake	MEXICO: **Jalisco:** 2 mi. NW. of Tequila, *S* 739.	11
****Tricarpha durangensis* Longpre	MEXICO: **Sinaloa:** 21.9 mi. NE. of Santa Lucia, *KC* 8860A.	8 (Fig. 17)
Tridax coronopifolia (Kunth) Hemsl.	MEXICO: **Michoacán:** 2.8 mi. S. of La Barca, *KC* 9039A.	9

Tridax mexicana A. M. Powell	MEXICO: **Jalisco:** 6.1 mi. E. of Jalisco-Nayarit boundary on Rte. 15, *KC* 8992.	9
Tridax procumbens L.s	MEXICO: **Sinaloa:** 44 mi. SE. of Culiacán, *KC* 8804.	18
***Tridax tenuifolia* Rose var. *microcephala* Rose	MEXICO: **Sinaloa:** ca. 40 mi. NW. of Mazatlán, *KC* 8808.	9 (Fig. 18)
Viquiera stenoloba S. F. Blake	MEXICO: **Coahuila:** 5 mi. W. of Saltillo, *S* 927.	ca. 34
***Zaluzania grayana* Robins. & Greenm.	MEXICO: **Chihuahua:** 36 mi. E. of Cd. Guerrero, *KM* 8379A.	17 (Fig. 19)
Zinnia angustifolia H.B.K.	MEXICO: **Nayarit:** ca. 18 mi. SE. of Tepic, *KC* 8966.	11

HELENIEAE

Bahia absinthifolia Benth. var. *dealbata* (A. Gray) A. Gray	MEXICO: **Coahuila:** 0.2 mi. E. of El Numbre, *KM* 7963 (ca. 24); 8.9 mi. N. of Rancho Acatita, *KM* 8073A.	24
Bahia pedata A. Gray	MEXICO: **Chihuahua:** 29.9 mi. S. of Cd. Jiménez, *KM* 8221A. UNITED STATES: **Texas:** CULBERSON CO.: 3.7 mi. W. of Van Horn, *KM* 7688. PRESIDIO CO.: 13.1 mi. SE. of Presidio, *KM* 7776.	12
Dyssodia aurea (A. Gray) Nels. var. *polychaeta* (A. Gray) M. C. Johnst.	UNITED STATES: **Texas:** BREWSTER CO.: Big Bend Natl. Pk., 8.7 mi. N. of headqtrs., *KM* 7821A.	8
Dyssodia papposa (Vent.) Hitchc.	MEXICO: **Puebla:** 8 mi. E. of Puebla, *KC* 9172.	13
Dyssodia pentachaeta (DC.) Robins. subsp. *pentachaeta* var. *belenidium* (DC.) Strother	MEXICO: **Coahuila:** 2.1 mi. N. of Rancho Acatita, *KM* 8066.	16

Florestina tripteris DC.	MEXICO: **Coahuila:** 63 mi. S. of Piedras Negras, *KM* 7847A. **Durango:** 16 mi. S. of Nazareno, *KM* 8030A.	10
Gaillardia pulchella Foug.	UNITED STATES: **New Mexico:** GRANT CO.: 0.3 mi. S. of jctn. Rtes. US 180 & NM 61, *KM* 8460A.	17
Gaillardia pinnatifida Torr.	UNITED STATES: **New Mexico:** HIDALGO CO.: 14 mi. NE. of Lordsburg, *KM* 8491A.	17
Gaillardia pinnatifida Torr. var. *linearis* (Rydb.) Bidd.[f]	MEXICO: **Chihuahua:** 2 mi. S. of Cuauhtémoc, *S* 1051.	17
Galeana pratensis (H.B.K.) Rydb.	GUATEMALA: **Jutiapa:** 7.3 mi. W. of jctn. Rtes. 3 & CA-1, *K* 9410. MEXICO: **Nayarit:** ca. 8 mi. SE. of Tepic, *KC* 8954-1.	9
Hymenoxys richardsonii (Hook.) Cockerell var. *floribunda* (A. Gray) K. F. Parker	UNITED STATES: **New Mexico:** HIDALGO CO.: 14 mi. NE. of Lordsburg, *KM* 8492A.	15
Nicolletia edwardsii A. Gray	MEXICO: **Coahuila:** La Rosa, *KM* 7922.	10
Palafoxia rosea (Bush) Cory var. *robusta* (Rydb.) Cory	MEXICO: **Veracruz:** 4 mi. NE. of Nautla, *KC* 9207.	11
Palafoxia sphacelata (Nutt. ex Torr.) Cory	MEXICO: **Chihuahua:** 43 mi. N. of Villa Ahumada, *S* 1115.	12
Palafoxia texana DC. var. *texana*	MEXICO: **Coahuila:** 0.8 mi. W. of San Raphael, *KM* 7966.	11
Pectis papposa Harv. & A. Gray var. *grandis* Keil	MEXICO: **Chihuahua:** 28 mi. W. of jctn. Rtes. 45 & rd. to Casas Grandes, *S* 1109.	12
Porophyllum coloratum (H.B.K.) DC.	MEXICO: **Jalisco:** 6.1 mi. E. of Jalisco-Nayarit boundary on Rte. 15, *KC* 8996.	12

Porophyllum punctatum (Mill.) S. F. Blake	MEXICO: **Veracruz:** 4 mi. NE. of Nautla, *KC* 9203.	12
Porophyllum ruderale (Jacq.) Cass. subsp. *macrocephalum* (DC.) R. R. Johnson	UNITED STATES: **Arizona:** SANTA CRUZ CO.: Peña Blanca Lake, *KC* 8585.	11
Schkuhria cf. *anthemoidea* (DC.) Coult.	MEXICO: **Jalisco:** 2.1 mi. NW. of Magdalena airport, *KC* 8998.	11
**Schkuhria pinnata* (Lam.) Cabrera var. *guatemalensis* (Rydb.) McVaugh	GUATEMALA: **Santa Rosa:** 3.5 km. NW. of Culiapa, *K* 9402A. MEXICO: **Nayarit:** ca. 8 mi. SE. of Tepic, *KC* 8956-1.	10 (Fig. 20)
Tagetes filifolia Lag.	MEXICO: **Sinaloa:** 3.8 mi. SW. of Santa Lucia, *KC* 8834A.	12
Tagetes lucida Cav.	MEXICO: **Nayarit:** ca. 18 mi. SE. of Tepic, *KC* 8968-1.	11
Tagetes micrantha Cav.	MEXICO: **Chihuahua:** 2 mi. S. of Cd. Guerrero, *KM* 8320A.	12
Tagetes subulata Cerv.	MEXICO: **México:** 1 mi. N. of Guerrero-México boundary on Rte. 55, *KC* 9101.	12
ANTHEMIDEAE		
Artemisia ludoviciana Nutt. subsp. *mexicana* (Willd.) Keck	MEXICO: **Durango:** 14 mi. SW. of La Ciudad, *KC* 8941.	18
SENECIONEAE		
Odontotrichum sinuatum (Cerv.) Rydb.	MEXICO: **Jalisco:** 1.2 mi. NW. of Magdalena airport, *KC* 9011.	30
Schistocarpha oppositifolia (Kuntze) Rydb.[h]	MEXICO: **Veracruz:** 11.8 mi. W. of Tuxpán, *KC* 9222.	8

****Senecio hartwegii** Benth.	MEXICO: **Durango:** 8.3 mi. SW. of La Ciudad, *KC* 8906.	ca. 30
****Senecio runcinatus** Less.	MEXICO: **Veracruz:** ca. 6 mi. E. of Las Vigas, *KC* 9192.	22 (Fig. 21)
MUTISIEAE		
Trixis californica Kellogg	UNITED STATES: **Texas:** BREWSTER CO.: 12.5 mi. N. of Castolón, *KM* 7814.	27
CICHORIEAE		
†*Pinaropappus roseus* Less.	MEXICO: **Veracruz:** 11.1 mi. E. of Puebla-Veracruz boundary on Rte. 150-D, *KC* 9177.	20_{II} & 1_{I} (Fig. 22)

[a]Unless indicated otherwise, the reported meiotic chromosome numbers represent bivalents.
[b]KC = *Keil & Canne*; [c]KM = *Keil & McGill;* [d]K = Keil; [e]S = *Stuessy.*
†Voucher determined by B. L. Turner, [g]A. M. Powell, [h]R. McVaugh.
*First report for variety, **species, ***genus.
‡New reported number for taxon.

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A VEGETATIONAL SURVEY OF THE VASCULAR PLANTS OF THE KENT ISLAND GROUP, GRAND MANAN, NEW BRUNSWICK[1]

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In 1930, Mr. J. Sterling Rockefeller, interested in preserving the eider ducks that breed along the coast of the northeastern United States, purchased Kent Island, on which the eiders nest. In 1934, he gave the island to Bowdoin College as a breeding bird preserve and field study station. Extensive ornithological work has been done at this station over the years, but there have been only limited botanical investigations. Dr. David Potter (1936, 1937) and John McCain (1973) compiled vascular species lists, and Henry A. Gleason, Jr. (1937) sampled herbaceous vegetation in the forested northern end of Kent Island. The present study was designed to survey and map the vegetation of the entire island and to define the plant community types in the non-forested areas. It is also intended to serve as a reference for future ornithological research on Kent Island.

Kent Island lies at 66°46′ E longitude and 44°35′ N latitude, about fifteen miles east of the coast of Maine in the Bay of Fundy. It is the outermost island in the Grand Manan Archipelago and is politically part of Charlotte County, New Brunswick, Canada. Its greatest length is 1.75 miles and its width varies from one-ninth to one-half mile. The title deed lists the area at 150 acres.

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All of Kent Island is now covered with water-worked glacial till (Meserve, 1937). The only major relief is an upland area with twenty-foot sand cliffs on the northern end of the island and two fifty-foot hills at the far southern end. The northern and western ends are heavily wooded, and the west end is low and marshy. A 7.8 acre tidal basin on Kent Island is flooded twice daily by tides averaging 14.4 feet. Kent is the largest of what local fishermen call the Three Islands. Fifty acre Hay Island is forested except for one large field on the south shore where a few now uninhabited houses and a weathered barn still stand. It can be reached on foot from Kent Island at low tide. Thirty acre Sheep Island is a low flat island with vegetation resembling the south end of Kent Island. It has no woody plants.

MATERIALS AND METHODS

I was able to spend six weeks during the summer of 1968 and ten weeks during the summer of 1969 on Kent Island at the Bowdoin Science Station. In 1968, a general survey of the plant cover of the entire Three Islands group was made, and quantitative sampling of the vascular flora of the forests was completed. Aerial photographs taken in 1965 were used to supplement the field studies in mapping the vegetation of the islands (Fig. 1). To determine the relative frequency of the forest herbs, a 100-foot grid was established in the wooded areas of Kent Island using a Brunton compass, and meter quadrats were set up at the intersections and at the 50-foot marks.

The non-forested areas, identified in the 1968 survey, were sampled in 1969 by the line-intercept method. A non-forested area, as defined for the purposes of this study, is one in which herbs or shrubs are the dominant species and where trees, if present, do not form a closed canopy. Eleven such areas were defined. In each area, either a two- or a five-hundred foot transect was established along a compass line. Absolute and relative dominance, and relative density were calculated for plant species intercepted, according to the

FIG. 1- VEGETATION MAP, KENT IS.

method of Cottam and Curtis (1962). Absolute dominance is expressed in this paper as "% cover", a measure of the number of herbs or shrubs of a given species intercepting each segment of the transect line. Since several different species may overlap one another, the total "% cover" will often exceed 100%. Relative frequency was determined through the use of nested quadrats offset by a random numbers table at twenty-five foot intervals along the transect line. The sum of relative frequency, relative density, and relative dominance (of woody species) is the Importance Value (IV) of a species on a given transect. The sum of all species' Importance Values on each transect should equal 300 for shrubs, 200 for herbs.

Soil samples were taken from the A_1 layer at each sixty-five foot mark, and used to determine soil moisture and water retaining capacity (WRC) by the Hilgard-cup method, and pH by the use of pHydrion paper. In soils with high organic content, the WRC values often exceed the dry weight of the soil itself.

Seymour (1969) was used for the identification of the plant specimens with the exceptions of the two groups indicated in the previous paper on the Kent Island flora (McCain, Pike & Hodgdon, 1973).

RESULTS

Collections totaling 240 species and 10 varieties of vascular plants were made on the Three Islands in 1935 by Dr. David Potter of Clark University, in 1968-69 by the present author, and in 1970 by Dr. A. R. Hodgdon and R. B. Pike of the University of New Hampshire. These collections were listed in McCain *et al.* (1973). Ninety-four of the genera in the total list (66.2%) are represented by one species only, as are twenty-one of the families (39%). Of the fifty-four families, six (Gramineae, Cyperaceae, Polygonaceae, Caryophyllaceae, Rosaceae, and Compositae) account for 48% of the species present on the island, and for 100% of the species intercepted in the nesting areas of

the islands' sizable herring gull population. The presence of these birds may be the main cause of the lack of floristic diversity.

Eighty-five one-meter quadrats sampled in the forested areas showed a ground layer homogeneous in species composition but widely varying in density of individuals. In the more open areas, or along the forest edge, *Dryopteris spinulosa* var. *americana* was clearly dominant and the total higher plant cover averaged 88.13% under spruce-fir and 70.56% under mountain ash and canoe birch (*Betula papyrifera* var. *cordifolia*). Where the spruce are 20-30 feet tall, they form a very dense thicket. Here the higher plant cover averaged only 32.86%, with *Oxalis montana* and *Maianthemum canadense* dominant. In several of the denser spruce thickets, higher plant cover was entirely absent in the herb layer. The understory there suffered not only from a lack of light but also from a shortage of soil moisture. Most rain is intercepted by the dense canopy and most of the throughfall is caught by the deep litter layers before it can penetrate to the soil itself where it would be available for the understory plants. Mean higher plant cover in all eighty-five quadrats was 55.17%. Lower plant cover averaged 31.43% in the dense areas, 10.89% under the open stands.

The most important herb species in the wooded areas was *Aster acuminatus* (%F = 60.0). *Rubus idaeus* var. *canadensis* was the most common woody species, occurring in 28.2% of the quadrats. In openings or blowdowns, it often accounted for nearly 100% of the cover. Table 1 shows the relative frequency values for the forest floor species. Gleason (1937) sampled one hundred similar plots on Kent and Hay Islands, finding corresponding values for the species present. The major exception was that *Oxalis montana* was the most abundant species in his study, occurring in 44% of his quadrats. In 1968, *O. montana* was present in 24.7% of the quadrats in the total sample, but was present in 71% of the quadrats in denser areas where the spruce was roughly 25-40 years old. This change in the presence

of *O. montana* suggests a change in the age structure of the tree population, with the sorrel giving way to larger species, often *Dryopteris* or the mountain aster, in the older, less dense woods.

Table 1. Kent Island species occurring in more than 5% of forest area quadrats sampled, 1968.

Species	% frequency
Shrubs	
Rubus idaeus L. var. *canadensis* Richardson	28.2
Herbs	
Aster acuminatus Michx.	60.0
Dryopteris spinulosa (O. F. Mueller) Watt. var. *americana* (Fischer) Fern.	38.8
Rumex acetosella L.	38.8
Oxalis montana Raf.	24.7
Trientalis borealis Raf.	21.1
Maianthemum canadense Desf.	16.4
Cornus canadensis L.	10.2
Poa pratensis L.	9.4
Circaea alpina L.	9.4
Impatiens capensis Meerb. forma *immaculata* (Weath.) Fern. & Schub.	8.3
Stellaria media (L.) Cyrillo	8.2
Anthoxanthum odoratum L.	7.1
Carex brunnescens (Pers.) Poiret var. *sphaerostachya* (Tuck.) Kukenthal	5.9
Streptopus amplexifolius (L.) DC. var. *americanus* Schultes	5.9

Four groups of non-forested stands can be clearly defined. The first includes the old fields near the middle of Kent Island and the main field on Hay Island. All are composed of turf grasses like *Agrostis stolonifera* and *Festuca rubra* and perennial composites such as *Solidago rugosa* var. *villosa*. These fields are relatively sheltered both from the salt spray and the weather but show the greatest influence

of man both in terms of cutting and of introduced species. Most of these areas were cleared for planting of forage crops, notably *Phleum pratense*, in the nineteenth and early twentieth centuries. Shrub cover is uniformly low: 1.0, 14.40, 16.60, and 16.71% on the transects studied. Herb cover is the highest of the four groups, with an average in these fields of 386.37%. The old field transects all included a greater number of plant species than any of the other transects studied.

The second group consists of raspberry and shrub communities. *Epilobium angustifolium* is found in association with *Rubus idaeus* var. *canadensis* in blowdowns and open areas along the north and east shores of Kent Island. Shrub cover values are uniformly high with a mean of 103.96%, but herb cover dropped to 180.37%. Each of these areas is the site of active gull nesting, and, as a result, has a very rich soil with a high organic content.

Fresh-water and salt marsh communities along the western shore of Kent Island and on the north shore of Hay Island are in the third group. *Iris versicolor* (Importance Value = 19.46), *Carex canescens* var. *disjuncta* (IV = 23.18) and *Epilobium glandulosum* var. *adenocaulon* (IV = 20.65) are the most important species of these areas. Shrubs, but for *Ribes lacustre*, are seriously limited, except where the marsh is the last remnant of an old raised bog. In those places, *Kalmia angustifolia* and *Ledum groenlandicum* are the dominants, growing over *Sphagnum* moss. Only one small part of a formerly very extensive bog is left on Kent Island because of the maturing of the forests and man-made changes in the drainage patterns. There is one heath remnant, perhaps twenty feet in diameter, at the north edge of the bog area, the sole location found for five species of the flora: *Calopogon tuberosus*, *Arethusa bulbosa*, *Sarracenia purpurea*, *Rubus chamaemorus* and *Empetrum nigrum*.

In the fourth group, the South Hills of Kent Island and all of Sheep Island, are the main nesting areas of the islands' estimated 23,000 breeding pairs of herring gulls.

This very disturbed area supports dense populations of several plant species found only infrequently elsewhere on the island, and then only as weeds. For example, common ragweed (*Ambrosia artemisiifolia*) normally loses out in competition to the grasses and other composites. On the South Hill, however, *Ambrosia* has an importance value of 58.02, second only to *Aster foliaceus* var. *arcuans* (IV = 64.62). *Rumex acetosella,* another weed, is similarly favored by these disturbed conditions (IV = 14.28). The number of species found on the South Hill is also undoubtedly held down by the gulls. Only eight herb species and one shrub (*Rubus idaeus* var. *canadensis*) appeared on the 500 feet of South Hill transects. By comparison, the four old field transects averaged 26 herb species and 3 shrub species.

Clearly the most frequent herbaceous species of the non-forest areas is the ubiquitous blue aster *A. foliaceus* var. *arcuans*. On all four field transects, on the north shore of Hay Island, and on the gull hills at the south end of Kent Island, it is the species with the highest importance value. *Aster foliaceus* was present in some degree in all eleven of the transect samples.

The most frequent shrub species, in both forested and non-forest areas, is *Rubus idaeus* var. *canadensis*. Raspberry plants covered over half of the line on the four shrub community transects: the south field (% cover — 92), North Clearing (86.5%) Downer's Field (51%), and the Crockett's Point Field (69%). No other shrub was so clearly dominant in any of the areas sampled. *Ribes lacustre* was a dominant shrub (18% cover) in the Hay Island north shore marshes, but, where *Ribes* and *Rubus* are both present, the red raspberry is clearly more dominant than the currant.

Soil moisture values vary from 19.5% in the North Field to 69.0% on the South Hill (Table 2). The South Hill also varies significantly in mean pH values from the rest of the island. The other groups of stands have mean pH values of 5.67, 5.77 and 5.60, while that of the South Hill is only

4.93. WRC values are consistent within each of the four groups, except for a high of 629.90% on Crockett's Point where much poorly decomposed *Sphagnum* moss appeared in the soil profile. Soil data is summarized in Table 2. The extreme values for soil moisture and pH in the South Hill are certainly factors in the presence of a vegetation typical of disturbed areas. However, careful study may show that the mechanical destruction of plants due to the perching, pulling and pecking of the gulls may be more harmful to plant survival than the chemical alteration of the soil caused by their droppings.

Table 2. Soil analysis data.

Stand	Transect	% Soil Moisture	pH	WRC (%)
North Field	I.	19.5	6.05	121.18
Hay Field	II.	26.2	5.58	148.50
West Field	III.	29.8	5.40	82.96
East Field	IV.	34.4	5.38	61.95
North Clearing	V.	28.0	5.80	105.55
South Field	VI.	34.7	5.70	22.64
Downer's Field	VII.	39.5	5.80	29.42
Crockett's Point	VIII.	41.0	5.80	629.90
West shore	IX.	40.0	5.70	425.44
Hay north shore marsh	X.	40.2	5.50	300.00
South Hill	XI.	69.0	4.93	196.53
Mean Values				
Transect Group				
I-IV (Old fields)		27.48	5.67	103.50
V-VIII (Shrubs)		35.80	5.77	*52.54
IX-X. (Marshes)		40.10	5.60	362.72
XI. (South Hill)		69.00	4.93	196.53

*discounting high value for transect VIII.

The remaining botanical area of the islands is a zone just above the highest tide lines, favored mostly by halophytes, the most important among them apparently being *Cakile edentula*, *Atriplex patula* var. *hastata* and *A. glabriuscula*, *Lathyrus japonicus* var. *pellitus*, *Mertensia maritima*, and *Arenaria peploides* var. *robusta*. There are also a few perennials mixed in at the upper edge of this zone, notably *Aster foliaceus* and *Urtica procera*. A few plants have ventured out onto the floor of the tidal basin where they are covered twice daily by the waters of high tide: *Salicornia europaea*, *Glaux maritima*, *Limonium nashii*, *Suaeda maritima* and *S. americana*. Prominent growths of *Spartina alterniflora* and *Hordeum jubatum* line the edge of the basin. No statistical sampling has yet been done in these zones.

DISCUSSION

Three characteristics of the flora are especially worth noting. The first is the paucity of species. About one-half of the genera (56.44%) and one-fourth of the families (27.37%) in mainland New Brunswick are represented by a single species (Fowler, 1885). On Kent Island, two-thirds of the genera and two-fifths of the families are monotypic. The recentness of colonization could be a factor in the lack of diversity of flora, for all of the Grand Manan Island group was covered during the last glaciation. Thus there has been little time for proliferation of immigrants. The second possible factor is the presence of the herring gull colony. In work on three similar islands nearby in the Bay of Fundy, Hodgdon and Pike (1969) concluded that "the screening effect of bird populations is more apparent than their transport of propagules". This seemed to be true on Kent Island where the gulls probably prohibit by their activities the establishment of many potential immigrants and of many woody species. The continual disturbance caused by the birds maintains the area in early stages of succession. The abundance of a group of fast growing, sun

loving species typical of pioneer habitats, including *Achillea millefolium*, *Rumex domesticus* and *R. acetosella*, *Urtica procera*, *Coelopleurum lucidum* and *Ambrosia artimisiifolia*, indicated that these plants apparently benefited from the gulls' presence.

The second notable characteristic of the flora is the presence of a high number of boreal species for this latitude. Nearly three-fourths of the Kent Island species have ranges that extend north and west from this area. Such species as *Rubus chamaemorus*, *Empetrum nigrum*, *Vaccinium vitis-idaea*, *Stellaria humifusa*, and *Euphrasia americana* reach their extreme southeastern limits in the Kent Island region. The reason for their presence here is the cool, damp climate of the Bay of Fundy. The warm Gulf Stream and the cold Labrador Current meet near the mouth of the Bay. During the summer the prevailing wind is from the south or southwest over 50% of the time. Thus the air is considerably warmer than the waters of the Labrador Current and of the Bay of Fundy (which seldom exceeds 50°F. even in midsummer) and the result is very frequent dense fog.

In the ten-day period beginning 26 July 1969, for example, the greatest visibility was just under one mile and the mean daily low visibility was about one hundred feet. The fog-drip caused by the condensation of this heavy fog on tree limbs increases the humidity at the herb level.

Table 4 shows pertinent weather data for the years 1965-69. Year-round weather records for the five-year period 1937-1941 may be found in Cunningham's report (1942).

The third important characteristic of the flora is that many of the new species reported in 1968-69 are weeds evidently introduced by man, probably after the previous studies were done in 1936. Thirty-one of these sixty-one new species were found in the field where the houses are on Hay Island, and on Kent Island near the wharf, along the main path, or in the area of the dormitory in the central part of the island. Conspicuous among these species are *Trifolium pratense*, *Convolvulus sepium*, *Chenopodium*

album, *Galeopsis tetrahit*, *Chrysanthemum leucanthemum*, and *Hieracium aurantiacum*. These species are often spread by man, and are too conspicuous to have been missed by Potter in his work.

Nearly all of Kent Island was once wooded and has been cut over at one time or another (Gleason, 1937). The northern and western ends are now wooded, with white spruce (*Picea glauca*) dominant in successional areas where the forest is encroaching on the fields and in blow-down areas. Balsam fir (*Abies balsamea*) is reproducing better in the more established woods.

Table 3. Herbaceous and woody species cover.

Stand	Transect	Shrub cover (%)	Herb cover (%)
North Field	I.	16.71	421.56
Hay Field	II.	1.00	489.50
West Field	III.	16.60	317.40
East Field	IV.	14.40	317.00
North Clearing	V.	86.50	212.50
South Field	VI.	184.00	93.00
Downer's Field	VII.	69.00	203.00
Crockett's Point Field	VIII.	76.33	212.97
West shore marsh	IX.	10.00	389.00
Hay north shore marsh	X.	7.50	156.00
South Hill	XI.	16.80	175.40
Mean Values			
Transect group			
I-IV (Old fields)		12.18	386.37
V-VIII (Shrubs)		103.96	180.37
IX-X (Marshes)		8.75	272.50
XI. (South Hill)		16.80	175.40

Table 4. Meteorological summary of Kent Island, New Brunswick, Canada, 1965-1969.
(Bowdoin Science Station Weather Records)

Month	Avg. Mean Max. T.°F.	Avg. Mean Min. T.°F.	Avg. Total Prec., in.	Avg. Days Fog/Month
June	57.2	44.6	2.49	13.0
July	61.8	48.8	2.44	17.8
August	62.3	50.5	3.08	15.6

Avg. total days with fog for the three month period: 46.4.
Mean annual precipitation (Cunningham, 1942): 44.86″.

The four classes of non-forested areas vary in terms of soil water and plant cover. Table 2 lists soil moisture content, water retaining capacity, and pH by transects and Table 3 lists woody and herbaceous species cover by transect. In the old fields, the driest areas studied, the herbaceous species seemed to be encouraged. As the moisture content of the soil increased, the shrubs increased, but the total water the site could hold decreased as did the number of herbs. In the marshes the water content became high enough to inhibit the number of shrubs, and another group of herbaceous species took over.

Finally, the highly organic soil of the South Hill had a high moisture content, but a lowered WRC. This is surprising since water retaining capacity usually increases with increased soil organic content. The increased acidity of these areas may have limited both the herbs and shrubs in variety. Where the gulls nest in areas with trees, they are destroying the woody plants. The south hills of Kent Island were formerly forested, as is evidenced by many fragments of decaying wood found in the soil, but the constant influence of the gulls has left only an area of twisted and broken snags where *Rubus idaeus* has now taken over. Many trees have been killed by the severe mechanical damage caused by the gulls. Some others have become stunted

and have formed an unnaturally dense and tangled crown, thick enough and strong enough to support a man.

In some of the most heavily disturbed areas, the grass pulling of the gulls keeps large areas of ground completely barren of all vegetation. The largest such barren area in 1969 measured nearly fifty feet by thirty feet. The vegetation around these barren areas is almost purely *Ambrosia artemisiifolia*. This weedy species emphatically underlines the extreme disturbance by the gulls of this part of the island. Nowhere else in the Three Islands group are conditions nearly so favorable for this species.

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A RED-PETIOLED FORM OF THALIA GENICULATA L. FROM CENTRAL FLORIDA

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In 1967 several unusual plants of *Thalia geniculata* were noticed growing in a wet disturbed area caused by the widening of State Road 192, located ten miles west of the town of Melbourne Village, Brevard County, Florida. These Thalias had become established along with other herbaceous aquatics to the north of the road after construction on the road had ceased. The disturbed site was of very sandy soil which often became flooded by heavy rains. These plants were noticeably different from the usual all-green form of *Thalia* by the presence of bright red petioles and petiole sheaths.

For unknown reasons the plants disappeared and it was not until 1972 that the red form was again seen in the same vicinity, this time in the ditch to the south of State Road 192 and west of where it was originally sited. Additional searching later uncovered several small populations to the east and west of the population found in 1972. The same year a stand of red-petioled Thalias was seen in a cattle pasture to the east of the Military Trail, northwest of the city of Palm Beach, Palm Beach County, Florida. This population has since been destroyed.

The most striking aspect of the red form of *Thalia geniculata* is the bright rhubarb red coloration of the lower petiole and petiole sheaths. This coloration is carried farther by the presence of a red pulviniform area (usually greenish or orangish in the green form) at the base of the leaf blade, and by varying degrees of red on the joints and axes of the inflorescence. Red may also occur at the margin of the upper side of the leaf blade.

In the green form of *Thalia geniculata*, no red coloration occurs except for a red spot which may be found on the upper surface of the leaf blade where the blade meets the pulviniform area at the top of the petiole.

Thalia geniculata L. f. **rheumoides** Shuey, forma nova

A forma *geniculata* differt basibus vaginisque petiolorum rubris et inflorescentiae furcis, axibus, bracteisque principalibus rubris vel viridi-rubris, necnon area pulviniformi ad apicem petioli cremea usque rubra.

Holotype: Florida: *Brevard Co.:* on south slope of water filled ditch, base of plant at water line, growing in full sun with grasses, other herbaceous plants, and the green form of *Thalia geniculata,* south side of State Road 192, 10 mi. west of the town of Melbourne Village, *Shuey* 105571 (*USF*).

The form name *rheumoides* is derived from *Rheum,* the generic name for rhubarb, and *oides,* Greek suffix meaning similar to; this was selected because the red stem sheaths are rhubarb red, looking like the petioles of the red varieties of rhubarb. This form of *Thalia* is capable of perpetuating itself — numerous small seedlings exhibiting red coloration being noted at several sites.

The coloration of the petiole stalks and sheaths does not vary to any great degree from one plant to another, but the color of the axes of the inflorescence varies considerably. Some plants exhibit slight coloration only around the joints, bracts and bases of the inflorescence, while others tend toward conspicuous coloration over much of the axis.

The coloration of the plants is very much influenced by light intensity. Plants growing in full sun have deeply colored petiole stalks and sheaths. Plants growing in the shade, on the other hand, have sheaths which are almost green, but retain the distinct red color near the margin of the sheath. This is lacking altogether in the green form.

It is interesting that several plants dried for herbarium material retained a strong red tinge around the joints of the inflorescence and especially on the stem sheaths.

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THE TAXONOMY OF TRIPOGANDRA (COMMELINACEAE)[1]

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INTRODUCTION

Although some species of commelinaceous plants — *Tradescantia* and *Zebrina* — are very well-known in introductory courses in biology and botany for their use in demonstrating cyclosis, plasmolysis, and anther squashes, and while cytologists consider species of *Tradescantia* good teaching material and popular research subjects because of their large chromosomes, taxonomists have not agreed as to generic limits or relationships within the family. The problems of generic delimitation within the Commelinaceae have existed almost since the time of Linnaeus. Concepts have changed through time and even a careful and observant worker such as C. Kunth modified his concepts of the genera during his working years as is evidenced by his transferral of species from one genus to another. In recent years the publications of Aristeguieta (1965), Hutchinson (1959), Matuda (1956), Moore (1960, 1963), Pichon (1946), Rohweder (1956), and Woodson (1942) illustrate the different concepts each investigator has of various genera, especially those American genera related to *Tradescantia*.

Tripogandra has been included in what has been called the *Tradescantia* alliance. The United States species of this alliance were studied by Anderson and Woodson (1935) and were found to form a uniform group of species. *Tradescantia* outside of the United States contains diverse elements, and a study of *Tripogandra* was considered in the nature of an introduction to the whole alliance. As

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delimited by Woodson (1942) on the basis of inflorescence structure, *Tripogandra* was not well understood and contained a number of species of questionable affinity. Moore's (1960) investigations showed that some species had a modified androecium which suggested an important biological function probably related to insect attraction, assuring pollination and out-crossing. A detailed study of the species included in *Tripogandra* was thought to be one way of approaching the problem of generic delimitation and of determining the relationship of *Tripogandra* to its closest relatives and to the remainder of the family.

Here I have delimited *Tripogandra* to include only those 20 species which have dimorphic stamens and double cincinni not subtended by foliaceous bracts. These species are described in detail while the other species which have been included in *Tripogandra* at some time in the past are not considered congeneric and are not described in detail. These species and reasons for exclusion are to be found at the end of this paper.

HISTORICAL REVIEW

Tripogandra was first proposed by Rafinesque in 1837 to contain one species, *Tradescantia multiflora*. Rafinesque's publications were not widely available and his taxonomic decisions were not always accepted by other botanists. As a result, the name *Tripogandra* was not adopted by the botanical community until much later. When Rafinesque published *Tripogandra* he also proposed the following as segregants from *Tradescantia: Sarcoperis, Siphonstima, Gibasis, Etheosanthes, Tripogandra* (based on *Tradescantia multiflora* Jacq.), *Phyodina, Leiandra, Heminema* (based on *Tradescantia multiflora* Swartz), and *Aploleia*. Rafinesque concluded his proposals with the following comments:

"These 3 last Genera [*Leiandra, Heminema, Aploleia*] lack the very essential characters of bearded Stam. that once was the only distinction of *Tradescantia* from *Com-*

melina, but these 2 Genera are in utter confusion, as the above proves. Compare also my genera of *Commelina*. It is deplorable to see Botanists forcing sp. into genera, in spite of characters. There is not a single generic character common to all the above G. 22 to 32! my reform and revision were indispensable, and begun in 1815. . . . this whole Genus is a mass of linnean errors."

Rafinesque was correct by present criteria in believing that several generically different elements were present in *Tradescantia*, but he did not solve all the problems. Both *Tripogandra* and *Heminema* are based on the same type, though Rafinesque credits two different authors. Rafinesque may have been misled by the apparent though not real differences between Swartz's original description and Jacquin's description and illustration. Woodson (1942) united *Heminema* and *Tripogandra* and his choice of *Tripogandra* must be followed according to Article 57 of the International Code of Botanical Nomenclature (1966).

Kunth in 1843 considered the entire family and described sixty species of *Tradescantia* which he divided into several groups, one being "Species anomalae." This group was characterized by anthers of two shapes, with three longer and three shorter filaments. All of the species in this group are presently considered in the genus *Tripogandra*.

Schlechtendal (1853) proposed the name *Descantaria* for the species which Kunth included in his "Species anomalae." Schlechtendal wrote that those species seen by him were distinguished by three bearded perfect stamens and three beardless imperfect stamens. No combinations were made by Schlechtendal however.

In 1866, Hasskarl used *Disgrega* as a generic name in a key with *Tradescantia disgrega* in parentheses probably indicating that this species belonged to the genus *Disgrega*, but no formal transfer of the species was made.

Clarke (1881) dealt with the Commelinaceae as a family. He divided the genus *Tradescantia* into three sections, one of which was Descantaria, characterized by three longer

and three shorter stamens more or less dissimilar. Clarke (in Donnell-Smith, 1902) described the genus *Donnellia* characterized by a three-valved capsule, locules bearing one seed, and based on *Callisia grandiflora* which was originally described as having two groups of dissimilar stamens. He was prompted to write that in his previous work on the family

> "no attempt is made to deal with the genera 'logically,' the same characters, which in the American genera (*Tradescantia* and its allies) constitute genera, only constitute subgenera in *Commelina* and *Aneilema*. . . . convenience has been preferred to any logical system."

Donnellia was found to be a later homonym and Rose (1906) proposed the name *Neodonnellia* for the genus.

Clarke's work has caused concern among taxonomists and Anderson and Woodson (1935) note that Clarke's

> "revision of the genus *Tradescantia* reflects little credit upon the author, when compared with the critical, if eccentric observation of Rafinesque nearly a half century previously. Not only was Clarke satisfied to ignore the complexity of the genus by unwarranted reducing to strict synonymy or ambiguous varieties most of the species proposed by his predecessors, but the literature was complicated by the publication in synonymy of unpublished names of other botanists, and the misinterpretation of numerous others. The revision of the genus in the 'Monographiae' is clearly a piece of chorework reflecting rather a none too laborious attempt at compilation than a lively interest and acuity."

Brückner (1927) chose Schlechtendal's name, *Descantaria*, as the generic name for several of the species now included in *Tripogandra* and formally transferred those species. Brückner had suggested these transfers in 1926 when he had published a complete description of *Descantaria* and gave Schlechtendal credit for proposing the name. No synonyms were given by Brückner until 1930, when

he listed *Descantaria* Schlechtend., *Heminema*, *Tripagandra* [sic] Rafin., and *Disgrega* Hassk. It is not clear why Brückner chose a name which lacked priority. A possible reason is that he had no first-hand knowledge of Rafinesque's publication. Brückner's misspelling of *Tripogandra* is the same as that in Index Kewensis, fasc. 4, which may have been Brückner's only acquaintance with the name.

The American members of the Commelinaceae were treated by Woodson (1942) in an attempt to better delimit the genera. A number of transfers were made in the newly delimited genera, and *Tripogandra* was discussed at length. Woodson suggested new approaches to the family, stating that

"the Commelinaceae always have been difficult subjects for herbarium study because of their deliquescent flowers. It is not easy to understand, therefore, why previous systematists of the family have focused almost their whole attention upon floral structure in the delimitations of subfamilies, tribes, and genera."

Woodson felt that stamens were too variable a character to use for a major subdivision of the family and pointed out Brückner's inconsistency in dividing the family into two subfamilies and then placing *Descantaria* in the Hexandrae and *Neodonnellia* in the Triandrae. I believe Woodson was correct in considering *Descantaria* and *Neodonnellia* as congeneric. Woodson suggested that a major subdivision of the family could be made using inflorescence structure. In his concept of the tribe Commelineae, the ultimate units of the inflorescence are individual scorpioid cymes while in the Tradescantieae the basic structures "are paired sessile scorpioid cymes which appear as a 2-sided unit superficially, . . ." Woodson's concept of *Tripogandra*, which was placed in the Tradescantieae, was based primarily on inflorescence structure so it included more species than I have included. Woodson included species of *Leptorhoeo* and *Cuthbertia* which have six similar stamens because these species lacked foliaceous bracts subtending

the paired cymes. Previous authors and I have considered the two dissimilar whorls of stamens and their position as characters which delimit the most natural grouping of species.

Brückner (1930), Hutchinson (1934, 1959), Woodson (1942), Pichon (1946), Rohweder (1956), and Brenan (1966) have all dealt with the problems of generic definition and the characters used within the family to delimit them. Different emphases were used by each author but in general a consideration of several characters was found necessary for more satisfactory treatments. *Tripogandra* and some of its species have been considered in recent years in studies of restricted scope by Macbride (1936, 1944), Standley and Steyermark (1944, 1952), Matuda (1956), Moore (1960), Bacigalupo (1964, 1967), and Aristeguieta (1965), all of whom have been influenced to some degree by Woodson's work.

The genera of the Commelinaceae have been divided among various groups by the different authors listed above. No general consensus has been reached and all schemes are unsatisfactory to some extent. Brenan (1966) summarized the earlier schemes of classification and has divided the genera into fifteen groups. *Tripogandra* is considered in Group XI, which includes *Rhoeo*, *Campelia*, *Callisia*, *Aploleia*, *Tradescantia*, *Phyodina*, and *Cymbispatha*. Using Brenan's criteria, *Tripogandra* seems more closely allied to the species of this group than any other.

MORPHOLOGY

The morphology of *Tripogandra* has been investigated to varying degrees by taxonomists who have used certain characters in classifying the species, but the genus has never been systematically investigated by a morphologist. Tomlinson (1966) has been a primary investigator of morphology and anatomy having looked at the epidermis, hairs and stomatal patterns of three species. Brückner (1926) described in some detail the species *T. glandulosa*

(as *Tradescantia pflanzii*). More recently Rohweder (1963a) investigated shoot development and the course of vascular bundles near the apex of *Tripogandra pflanzii* (=*T. glandulosa*).

The following observations have been made on herbarium specimens and on living plants collected in México or grown in the greenhouse.

Habit. The plants of *Tripogandra,* whether annual or perennial, are succulent, weak-stemmed herbs. The plants may have an erect stem which is either branched or not. In erect, annual species — *T. amplexicaulis, T. angustifolia, T. guerrerensis,* and *T. palmeri* — branches may or may not develop from axillary buds. Plants in sunny, moist locations branch frequently. Crowded plants or those in shaded locations are commonly unbranched. Because the base of the plant is small and there is no secondary growth it is unable mechanically to support the weight of later growth. The base of the plant, therefore, becomes decumbent and additional support and anchorage is gained by the production of adventitious roots at the nodes of the decumbent stem. The presence of an intercalary meristem at the base of each internode allows the main stem to remain upright through differential growth and bending in these areas.

Some species, e.g. *Tripogandra disgrega, T. saxicola,* and *T. purpurascens,* may be either erect or trailing. This habit seems to be partly under genetic control; some plants have sturdier stems and grow upright while others produce weak, flexible stems which trail over the ground.

Perennial species such as *Tripogandra montana* and *T. serrulata,* commonly trail over the ground to a length of as much as two meters, producing adventitious roots at nearly every node which touches the soil. The flowering stems usually are erect. Branching occurs at irregular intervals. A vegetative branch is often produced from a node below the inflorescence. After growth of this axillary branch, the inflorescence appears to be borne in a lateral position, but

close examination shows the vegetative shoot to be in an axillary position and the inflorescence to be terminal.

Tripogandra grandiflora produces long upright shoots which are often supported by surrounding woody vegetation. Sheathing bracts or cataphylls are borne on the lower portions of the stem. Structures transitional between the cataphylls and a typical vegetative leaf can be found on most stems.

Root. All species of *Tripogandra* have fibrous roots. Thickened storage roots such as are found in species of other genera, i.e. *Tradescantia, Gibasis, Setcreasea, Separotheca, Dichorisandra,* and *Commelina,* have not been observed in any species of *Tripogandra.* The roots may be produced only at the base of the plant or they may be produced adventitiously from nodes along the length of the stem. Root initials may be differentiated early and remain dormant as has been reported by Tomlinson (1969) for species of *Tradescantia.*

Stem. The stems of all species of *Tripogandra* are more or less succulent structures. The stems as well as most other organs contain a mucilaginous juice which is exuded when the structures are crushed or broken. A common feature of most species is the presence of a line or band of hairs extending down one side of the internode (Fig. 4). The hairs within this line are always uniseriate, i.e. composed of several cells joined end to end. The terminal cell is not enlarged or modified in shape from the cells below it. This line of hairs is continuous with the line of hairs present on the sheath of the leaf above and is always found on the side of the stem opposite the leaf blade of that sheath. The line of hairs on the internode may extend the full length of the internode as in *T. saxicola,* may extend for part of the length of the internode as in *T. serrulata,* or occasionally may be lacking as in *T. grandiflora* or *T. amplexicaulis.*

Elsewhere hairs may be more or less uniformly scattered over the surface of the stem, as in *Tripogandra purpurascens* subsp. *australis,* or the stem may be glabrous as in

T. grandiflora. When present, the hairs may be uniseriate and resemble those in the line on the internode or they may have an enlarged distal cell and be called capitate as in *T. encolea.*

Leaf. The leaves of *Tripogandra* species are simple. The base is sheathing, forming a complete tube which is closely appressed to the internode. The leaf surface may be glaucous as seen in *T. amplexicaulis* and *T. amplexans,* but is more usually bright green and shiny. The dorsiventral blade is broad and flattened in all species except *T. angustifolia,* where the lamina is C-shaped or terete in cross-section and in *T. purpurascens* where the lamina is complicate. The base of the blade may be variously modified. It may be narrowed and subpetiolate as seen in some collections of *T. amplexicaulis* and *T. disgrega.* In some species, particularly on the stem just below the inflorescence, the base may be amplexicaul and surround the stem producing a superficially perfoliate appearance as in *T. amplexicaulis, T. amplexans,* and *T. encolea.* In other species — *T. diuretica, T. montana,* and *T. serrulata* — the leaf base is oblique, often rounded on one side and cuneate on the other.

Arrangement may be spiral as in *Tripogandra guerrensis* and *T. disgrega* or two-ranked (distichous) as most obvious in *T. grandiflora.*

The leaves may be glabrous or variously vestite and the vesture may be constant or variable within a species. The uniseriate hairs may be distributed on the leaves in the following fashions:

1. Both surfaces (abaxial and adaxial) as in some plants of *T. disgrega* and *T. diuretica;*
2. Abaxially (dorsally) as in *T. brasiliensis;*
3. Adaxially (ventrally) as in *T. saxicola;*
4. On the ventral surface over the midvein as in *T. serrulata* and *T. montana;*
5. Adaxially in a line near the margin as in some plants of *T. multiflora.*

Distribution of hairs is most variable in *Tripogandra multiflora* and is described further under that species.

The margins of blades are usually ciliate with uniseriate hairs except for some plants of *Tripogandra grandiflora* and *T. angustifolia*. Marginal hairs may vary in shape from species to species and have been illustrated for several species by Bacigalupo (1967). The distribution of marginal hairs may be regular or irregular, the latter condition being most apparent in *T. angustifolia*. The length of the hairs varies within species.

The orifice of the leaf sheath is villous in most species, although it may be glabrous in *Tripogandra amplexicaulis* and *T. grandiflora*. The hairs are multicellular and uniseriate and intergrade with those of the leaf margin.

Tomlinson (1969) has reported that a strand of collenchyma extends along the leaf margin in *Tripogandra*. In living material this strand can be seen as a light-colored line and is especially obvious in *T. grandiflora*.

The upper epidermis is colorless and the cells may be larger than any within the leaf. This phenomenon has been reported by Brückner (1926) for *Tripogandra pflanzii* in his description of leaf anatomy; I have seen these enlarged cells in *T. angustifolia* and *T. montana*. Tomlinson (1966, 1969) has found this specialized epidermis in several genera and assumes the function to be that of water storage.

The presence of silica bodies in the epidermis has been noted by Brückner (1926) and Tomlinson (1966, 1969).

The stomata have been described by Brückner (1926) and Tomlinson (1966, 1969) as having two accessory cells adjacent to the guard cells.

A weakly developed palisade layer may be seen in *Tripogandra montana* but is lacking in *T. angustifolia*.

Inflorescence. The basic inflorescence unit which appears throughout the family is the cincinnus according to Brenan (1966). The cincinnus as defined by Rickett (1955) is "a monochasium in which flowers appear alternately to right and left along one side of a sympodial axis."

The cincinni of a plant may be arranged in various patterns to form more complex, compound inflorescences. Brenan (1966) has illustrated some of the inflorescences in other genera.

The basic unit of the inflorescence in *Tripogandra* is also the cincinnus, but throughout the genus two cincinni occur fused together as in several other genera, e.g. *Tradescantia*, *Setcreasea*, *Rhoeo*, and *Zebrina*. The type of inflorescence has been called the "einfache Wickel zu zweien" by Brückner (1926), paired cymes or 2-sided cincinni by Woodson (1942), "Wickelpaare" by Rohweder (1956, 1963b), paired cincinni by Moore (1963) and dichotomous cymes by Mericle and Mericle (1969).

The constant, paired nature of the cincinni in several genera has been described by Brenan (1966) as "a peculiar fusion of each pair into a characteristic bifacial unit concrescent with its peduncle." Brenan has used the term "paired cincinni" to include structures which are bifacial as in *Setcreasea* and *Zebrina*, as well as geminate as seen in *Gibasis geniculata* where the inflorescence is characteristically composed of two separate and discrete cincinni each on an elongate peduncle.

I have used the term "double cincinnus" to refer to the bifacial, two-sided structure of the inflorescence which occurs in *Tripogandra*. The difference may be subtle but "double" seems to imply more in the nature of fusion than does "paired." Brückner (1926) used the term "Doppelwickel" which could be directly translated as double cincinnus. According to Rohweder's (1963b) translation, Brückner's definition of Doppelwickel was a structure "composed of two cincinni arising from the same node and being opposite in a strict morphological sense." Rohweder and Brenan consider this concept erroneous. My use of the term double cincinnus, if it arises through the fusion of two separate cincinni, may conflict with Brückner's concept of the origin of this structure. The origin of the bifacial structure has not yet been demonstrated.

The problem of terminology is further confused by Rickett's (1955) illustration of paired cincinni in *Myosotis scorpioides*. The structure shown corresponds to Brückner's Doppelwickel which I believe can be seen in the atypical inflorescences sometimes produced in *Gibasis karwinskyana*. I have chosen the term double cincinnus in lieu of a better term.

According to the definition of a cincinnus, each flower is terminal and the continuing axis is always an axillary one. This seems to be true for *Tripogandra*. The pedicel of each flower apparently bears a bract. In the axil of this bract a bud develops which is terminated by a flower which also bears a bract on its pedicel. The small bracts found on the top of the peduncle of all *Tripogandra* species represent these bracts.

The double cincinnus always seems to terminate a stem. Other shoots terminated by double cincinni may or may not be produced at lower nodes. A short shoot bearing several double cincinni may develop in a leaf axil, as in *Tripogandra multiflora* and *T. montana*, giving the impression that several double cincinni arise at a node. Close inspection shows the true nature of the situation. The double cincinni of *T. guerrerensis* are produced in a larger, much branched inflorescence so the appearance of the whole is that of a large panicle.

The number of flowers produced per double cincinnus is variable. The cincinni of some species — *Tripogandra montana*, *T. serrulata* — are long-lived, producing many flowers over a long period of time, and the sympodial cincinnus axis may become one or two centimeters long. On the other hand, *T. guerrerensis* and *T. amplexans*, produce only a few flowers on each ultimate unit over a short period of time.

The peduncle of the inflorescence may be either glabrous or variously vestite. The hairs may be in lines or bands and/or scattered. Hairs borne in lines or bands are always uniserate (*T. serrulata*), but the scattered hairs may be

either uniseriate (*T. multiflora*) or capitate (*T. amplexicaulis*). The peduncle length is variable, probably being determined both genetically and environmentally.

Flower. The flowers of all *Tripogandra* species follow the typical monocotyledonous pattern — three sepals, three petals, six stamens in two whorls or three stamens and three staminodes, and three carpels.

The sepals, which are usually green, contain one median vascular bundle and are more or less boat-shaped or hooded near the apex. The margin is hyaline and may or may not be pigmented. The sepals may be glabrous or nearly so (Fig. 3) as in *T. guerrerensis* and *T. grandiflora,* densely pilose with capitate hairs as in *T. glandulosa* and *T. purpurascens* (Fig. 1), pilose with uniseriate hairs as in *T. saxicola* (Fig. 2), or they may have only a few hairs at the apex as in *T. diuretica.* The hairs, when present, are often of diagnostic value. At anthesis the sepals may be reflexed but they close when the petals deliquesce.

The petals in all species are larger than the sepals and, depending on the taxon, vary in color from white to dark pink or magenta. Both white and pink flowers have been observed in *Tripogandra angustifolia, T. purpurascens* and *T. serrulata.* The petals remain open for only a few hours, commonly opening in the morning except for *T. saxicola* which flowers in the afternoon. All petals deliquesce a few hours after opening. The cell membranes apparently become permeable or break down during deliquescence allowing the cytoplasm to seep out of the cells as drops of liquid. The cell walls remain but the petal as a whole shrivels to a crumpled mass. The veins of the petals are difficult to distinguish in living material.

The androecium is dimorphic in all species; in bud it is actinomorphic but at anthesis it becomes zygomorphic as described below. The outer whorl of the androecium is always opposite the sepals and is composed of fertile stamens with short filaments (Fig. 25). The filaments are more or less subulate or awl-shaped and may be glabrous

as in *Tripogandra grandiflora* (Fig. 8) or bear one to many multicellular hairs on the dorsal surface (Figs. 10, 5). The number of hairs is variable within a species and has not been used as a taxonomic character. In dried material these hairs are almost impossible to detect. In the living state the cells of the hairs are variable in shape so the hairs may appear as long, uniseriate structures as in *T. palmeri* (Fig. 13) or as the classical moniliform hairs as in *T. purpurascens* (Fig. 5). The cells of the hair may be colorless, white, or pink.

The distal end of the filament forms the connective of the anther and the connective is usually somewhat expanded and thickened as is easily seen in *Tripogandra grandiflora* (Figs. 8, 9). Anther sacs are borne on the ends of the connective (Fig. 14). The anthers are usually extrorse in bud, but during anthesis bending of the distal end of the filament causes the anthers to become introrse or, with less bending, pollen is exposed upward. Dehiscence is longitudinal in all species (Fig. 8). The pollen is spherical to oblongoid and monosulcate.

The structures of the inner whorl of the androecium are borne opposite the petals (Fig. 25) and may be either staminodes which produce no functional pollen or stamens with functional pollen. In all species the filaments of these stamens or staminodes are longer than the filaments of the outer whorl of stamens. The filaments may be glabrous as in *Tripogandra guerrerensis* (Fig. 17) and *T. palmeri* (Figs. 21, 22), or variously bearded. The hairs may be borne on the dorsal surface as in *T. saxicola* (Fig. 20), around the filament as in *T. serrulata* (Fig. 19) and *T. montana* (Fig. 31) or in two more or less discrete patches as in *T. grandiflora* (Fig. 28). In all species the hairs are borne more abundantly on the middle or distal end of the filament. The cells of the hairs are usually spherical, producing the typical moniliform hairs, or cylindrical, producing uniseriate hairs as in *T. grandiflora* (Fig. 28). The cells of one hair are usually variable in shape and size, those at the base commonly being cylindrical while the

distal ones may be either cylindrical or spheroidal depending on the species. The cells may appear white, pigmented, or colorless.

The filaments of the stamens or staminodes of the inner whorl are bent to varying degrees. In all species two of the filaments bend at the base around the filaments of two outer stamens so the inner stamens or staminodes become aligned near the third inner stamen or staminode in front of the upper petal (Fig. 16). In addition, all filaments are bent in the middle. In *Tripogandra palmeri* the bend is C-shaped (Fig. 21); in *T. serrulata* (Fig. 19), *T. grandiflora* (Fig. 28), and *T. montana* (Fig. 31) the bend is an open S-shape; while in *T. guerrerensis* (Fig. 17), *T. amplexicaulis*, *T. amplexans* (Fig. 26), and *T. angustifolia* (Fig. 30) the bend is a more pronounced S-shape. The filament may be more or less expanded and inflated distally as in *T. amplexicaulis* (Fig. 23) or cylindrical as in *T. serrulata* (Fig. 19).

The connective and filament form a continuous structure in *Tripogandra palmeri* (Fig. 21) but the filament is very thin distally in species such as *T. guerrerensis*, *T. amplexicaulis*, and *T. angustifolia* (Fig. 27), and the anther then is more or less versatile. The connective may be elongate and straight, bent in the middle to form a V- or C-shape, or discoid. The anther sacs are borne on the ends of the connective and form a small part of the anther. Dehiscence is longitudinal.

The pollen from anthers of the outer whorl of the androecium may be fertile as in *Tripogandra serrulata* or modified and sterile as in *T. grandiflora* or *T. guerrerensis*. Lee (1961) first described the pollen within an anther of tetraploid *T. grandiflora*. This pollen varies in shape from nearly spherical to oblongoid to sub-fusiform and absorbs stain differentially from aniline blue-lactophenol. The pollen of diploid *T. grandiflora* stains uniformly, is more or less spherical, but is larger and has a more sculptured surface as compared to the pollen of the fertile stamens. The variation in pollen shape is greatest

in *T. amplexans* but within any one anther the pollen grains are uniform. Some collections produce spherical pollen which is externally indistinguishable from that of the outer whorl of stamens. In other collections the pollen grains are oblongoid or fusiform.

The gynoecium of the *Tripogandra* flower is composed of three fused carpels. Each carpel is supplied by three vascular bundles, two ventrals and one dorsal. Placentation is axile and two orthotropous ovules are borne in each of the three locules (Fig. 49). A short filiform style is found in all species. The shape of the stigma may be constant or variable within a species. The stigma may be simple and represent the top of the style, may be slightly enlarged (capitellate), greatly enlarged (capitate), or slightly penicilliform. In some plants the stigma may be somewhat three-lobed.

The pistil matures to form a loculicidal capsule which splits down the dorsal surface of each carpel. One to six seeds may be produced in each capsule. The lower ovule never matures in *Tripogandra palmeri*, consequently a maximum of three seeds is produced in each capsule of this species.

The orthotropous ovules develop into seeds with a dorsal embryotega. The embryotega represents that part of the integuments which lies over the embryo. In all species the position of the embryo is readily observed and is seen to be situated on the side of the seed opposite the hilum. The micropyle is also located on the side opposite the hilum — the embryo, in fact, develops just below the micropyle. As has been pointed out by Brückner (1926) for the family and as shown by Chikkannaiah (1962, 1963, 1964, 1965a, 1965b) from embryological studies of *Commelina*, *Murdannia*, *Floscopa*, and *Tinantia*, the relationship between the micropyle, the embryo and the embryotega is a constant one. In *Tripogandra palmeri* (Fig. 72) and *T. grandiflora* (Figs. 76, 77) the embryo and embryotega protrude from the surface of the seed but the margins of the seed are revolute and the embryo is more or less

surrounded and protected from mechanical damage. In other species of *Tripogandra,* the embryo is impressed and completely surrounded by the remainder of the seed. While the position of the embryotega is uniform within the genus it varies within the family. No detailed studies have been made of embryology and development of the seeds of *Tripogandra.*

The seeds of most species of *Tripogandra* are trigonal in outline. *Tripogandra amplexans* has seeds which are variable and they may be either trigonal (Fig. 59) or rectangular (Fig. 58) in outline. The seeds of *T. palmeri* and *T. grandiflora* are unique in having revolute margins. *Tripogandra palmeri* has the margin revolute in three places (Fig. 72), while *T. grandiflora* has the two opposite margins revolute (Figs. 76, 77). Seed outline is also dependent on the number of seeds which develop in a locule. The seeds become trigonal if both ovules develop (Fig. 76) but are more elliptical if only one develops (Fig. 77). The single ovules usually develop into larger seeds.

The appearance of the surface of the seed coat is of taxonomic value. Following the terminology of Murley (1951) the following categories of seed surface texture may be recognized among the species of *Tripogandra:*

1. Reticulate: *T. serrulata* (Figs. 38, 39), *T. montana* (Figs. 44-46);
2. Reticulate-foveate: *T. multiflora* (Figs. 32-35), *T. warmingiana* (Fig. 61);
3. Ribbed reticulate-foveate: *T. glandulosa* (Figs. 42, 43);
4. Areolate: *T. palmeri* (Figs. 72, 73), *T. saxicola* (Figs. 56, 57);
5. Ribbed areolate: *T. amplexans* (Figs. 58-60), *T. brasiliensis* (Figs. 47, 48), *T. disgrega* (Figs. 52, 53), *T. guerrerensis* (Figs. 68-71), *T. purpurascens* (Figs. 50, 51, 54, 55);
6. Farinose: *T. grandiflora* (Figs. 76-78);
7. Ribbed farinose: *T. angustifolia* (Figs. 74, 75).

The seeds of *Tripogandra amplexicaulis* are somewhat variable and are generally areolate but some collections have seeds which are also distinctly alveolate (Figs. 64, 65).

Tripogandra diuretica (Figs. 40, 41) produces seeds which are more or less intermediate between the ribbed areolate and the reticulate-foveate conditions and which could be called ribbed areolate-foveate.

The outline of the hilum may be punctiform (nearly circular) as in *Tripogandra angustifolia* (Fig. 75), *T. disgrega* (Fig. 53), *T. diuretica* (Fig. 41), *T. multiflora* (Figs. 33, 35), and *T. purpurascens* (Figs. 51, 55), linear as in *T. grandiflora* (Fig. 78) and *T. palmeri* (Fig. 73), or elliptical as in *T. brasiliensis* (Fig. 48) and *T. guerrerensis* (Figs. 69, 71). The outline of the hilum is constant within a species and is useful taxonomically.

The germination of *Tradescantia virginiana* (as *T. virginica*) has been described and illustrated by Gravis (1898) and that of *Commelina virginica* has been described by Bates (1939) but no previous studies have been made of *Tripogandra*. I have observed germination in detail in two species, *T. amplexans* and *T. purpurascens*. There are no significant visible differences in germination among the three genera.

When the seeds are wet they swell slightly and within a few days the seedling emerges. Studies by Chikkannaiah (1962, 1963, 1964, 1965a) of *Commelina*, *Murdannia* and *Floscopa*, as well as those by Gravis (1898) of *Tradescantia* show the radicle of the embryo situated directly below and adjacent to the micropyle and embryotega. I have observed, as did Bates and Gravis, that the radicle emerges from the seed first. The embryotega may be pushed to one side or lifted free from the seed and cap the root tip (Fig. 24). Through further growth the remainder of the embryo emerges from the seed. The tip of the cotyledon remains in the seed, presumably as an absorbing structure, while the cotyledonary neck or petiole elongates further. The first true leaf emerges from the sheathing base of the

cotyledon. By elongation of the radicle and first node, the seed and cotyledonary petiole may be lifted above the ground level.

CYTOLOGY

The cytological relationships of various Mexican Commelinaceae as well as a review and sumary of previous investigations are discussed in Handlos (1970).

Tripogandra is cytologically distinct from other genera. Karyotypes show both telocentric and metacentric chromosomes as well as larger and smaller chromosomes. The basic chromosome number is probably eight, though Jones and Jopling (1972) indicate the additional possibility of 13. Diploid chromosome numbers range from 16 to 64. Two species, *T. montana* and *T. saxicola*, with haploid numbers of 21 may be allopolyploids based on the numbers 8 and 13.

BREEDING SYSTEMS AND POLLINATORS

The genus *Tripogandra* is characterized by a distinctively modified androecium as was pointed out by Moore (1960). He suggested that the arrangement of stamens and staminodes, in addition to the self-sterility of the clone studied, indicated dependence on insect pollinators and the necessity of out-crossing in the species. Several other commelinaceous genera, including *Aneilema, Cochliostema, Commelina, Tinantia,* also exhibit various androecial modifications. Few studies have been made on the relationship between insects and the androecium in the Commelinaceae. Pollination has been studied in *Commelina* (Breitenbach, 1885), *Tinantia* (Knuth, 1906) and *Tradescantia* (Kerner von Marilaun, 1894; Sinclair, 1968).

From a series of 166 interspecific crosses involving *Tripogandra amplexans, T. angustifolia, T. palmeri,* and *T. purpurascens* subsp. *purpurascens* made in 1966, no interspecific hybrids were obtained. Flowers were bagged to exclude insects. All species studied proved to be self-

fertile. Further observations of *T. amplexicaulis, T. disgrega, T. diuretica, T. glandulosa, T. guerrerensis, T. montana, T. multiflora, T. saxicola*, and *T. serrulata* growing in insect-free greenhouses show that these species are also self-fertile. Of the 14 species observed, only *T. grandiflora* is self-sterile.

In 1967, I observed natural populations of *Tripogandra amplexans, T. amplexicaulis, T. angustifolia, T. disgrega, T. grandiflora, T. guerrerensis, T. montana, T. purpurascens, and T. saxicola* in México for a total of 61½ hours. Two hundred thirty-seven insects were observed of which 158 were captured. These insects are now in the collections of the Department of Entomology, Cornell University, as "Lot no. 994."

Hymenopterous insects formed the largest category of visitors. There were 60 individuals in the Apidae, 48 in the Halictidae, 20 in the Andrenidae, 4 in the Anthophoridae, 1 in the Coletidae. The bees formed the largest and most active group of insects and should be considered the most important pollinators. Bees only engaged in gathering pollen since the plants do not produce nectar. Some individual bees visited only the longer stamens (staminodes), others visited only the shorter, while still other bees crawled over all stamens and gathered pollen indiscriminately.

In only one species did I observe that the position of the staminodes caused bees to move in a restricted fashion in the flower. In *Tripogandra guerrerensis* the petals are not arranged symmetrically but instead at anthesis the two lower petals bend away from each other and are located nearer the upper petal; in this way an angle of approximately 90° is formed between either of the lateral petals and the upright petal, while the two lower petals are separated by 180°. The three staminodes arch out over the stamens and ovary. A bee can approach the stamens only by clinging upside down to the filaments of the staminodes. The significant position seemed to be that assumed when a bee was clinging to the staminodes and gathering pollen

from the anthers. The insect's abdomen then touched the anthers and pollen adhered to its body. It seems likely that pollen could be carried from flower to flower in this fashion and cross-pollination would thus occur. The significance of cross-pollination remains to be demonstrated in this species because these plants are also self-fertile. In other plants, Allard (1965) has shown that a large amount of variability is maintained though only a small percentage of outcrossing occurs. He believed that most individuals of a self-pollinating population would be highly homozygous but the recombination of genes introduced by a low level of outcrossing would provide sufficient new genotypes adapted to the microhabitats which occur in an area and would allow for increasing fitness of the species to a specific niche. Such reasoning may be applied to the annual and perennial self-fertile species of *Tripogandra* but further investigations should be conducted to determine the basic facts.

Some bee species, even when collected in small numbers, were found to visit two or more species of *Tripogandra*. One species of *Dialictus* was collected from four different species of *Tripogandra;* one species of *Pseudopanurgus* and another species of *Dialictus* were collected from three *Tripogandra* species, while three other *Dialictus* species, one species of *Evylaeus*, *Augochlora* near *smaragdina*, *Trigona fulviventris*, *T. mosquito frontalis*, and *T. testacea orizabaensis* were collected on two species of *Tripogandra*.

Many of the bees collected in this study are solitary bees which have been reported (Linsley, 1958) to be most abundant in warm semi-desert regions of the world. Many habitats in México can be described as warm and arid or border semi-desert or desert regions which may account for the many solitary bee species collected. The majority of solitary bees are oligolectic (Linsley, 1958) (oligotropic fide Faegri and van der Pijl, 1966), i.e. utilize only a few related species of plants as food sources. The social bees, *Trigona* and *Apis*, are probably polylectic (polytropic fide Faegri and van der Pijl), i.e. utilize food from un-

related plant sources. *Trigona mexicana* and *T. acapulconis* were both collected at one location in México. Some individuals were found on *Tripogandra* and others were caught on an abundant composite.

Tripogandra grandiflora, the only demonstrated self-sterile species produces strongly fragrant flowers. *Tripogandra amplexicaulis, T. saxicola,* and *T. purpurascens* subsp. *purpurascens* are *very* faintly scented. The scents produced may allow bees to identify and return to a specific source of pollen or, in the case of *T. grandiflora,* may allow bees to locate the plant because of its odor.

Of 23 dipterans collected, 18 were in the family Syrphidae. Faegri and van der Pijl consider these flies to be irregular and not very active pollinators. In *Tripogandra* I would confirm this observation. The three dipterans in the family Bombyliidae may effect some pollination but the remaining two flies and three beetles were probably not visiting the flowers for pollen and should not be considered to be important pollinators.

MEASUREMENTS

To prevent misunderstandings and to provide for consistent results I am giving below the methods by which I obtained my measurements. The length of the leaf blade is the distance from the tip of the leaf to the top of the sheathing leaf base. The length of the sheath is measured from the line of attachment at the node to the lowest point on the orifice of the sheath; this point is always on the side opposite the lamina. The diameter of the leaf sheath reflects varying amounts of inaccuracy because these measurements are from dried, pressed specimens. If the specimen is flattened and well-pressed, the measurement will be greater than the diameter in the living plant; if the stem is not well-flattened, the measurement may be close to that in the living state or even somewhat smaller. In either case, the sheath seems to shrink less than the stem during drying and is a more accurate esti-

mate of stem diameter than a direct measurement of the dried stem. The length of the peduncle is the distance between the subtending leaf and the base of the bracts at the distal end of the peduncle. The length of the pedicel is measured on flowers at anthesis. Anthesis is a definable period of a few hours duration and is used because it provides a uniform standard which is not subject to personal bias. Pedicels may elongate in fruit but a measurement standard would be more difficult to define. Measurements of flower parts are made on flowers at anthesis for the same reasons given above. The length of the filaments is the linear distance from the base to the connective disregarding curves and bends. The length of the anthers is the distance represented by the length of the anther sacs, while the width is taken as the distance between the anther sacs on the same anther. Pollen viability is judged by pollen stainability in aniline blue-lactophenol. The length of the ovary is the distance between the base of the ovary and the base of the style. The length of the style includes the stigma. The length of the capsule does not include the persistent style.

SYSTEMATIC ACCOUNT

Tripogandra Rafinesque, Flora Telluriana 2:16. 1837 ('1836'). TYPE: *Tradescantia multiflora* Swartz.

Heminema Rafinesque, Flora Telluriana 2:17. 1837 ('1836'). TYPE: *Tradescantia multiflora* Swartz.

Descantaria Schlechtendal, Linnaea 26:140. 1853; Brückner, Bot. Jahr. Syst. Beiblatt 137, 61:60, 61. 1926. LECTOTYPE: *Tradescantia multiflora* Swartz.

Disgrega Hasskarl, Flora 49:215. 1866. TYPE: *Tradescantia disgrega* Kunth.

Donnellia Clarke in Donnell-Smith, Bot. Gaz. 33:261. 1902; non Austin (1880). TYPE: *Callisia grandiflora* Donnell-Smith.

Neodonnellia Rose, Proc. Biol. Soc. Wash. 19:96. 1906. TYPE: *Callisia grandiflora* Donnell-Smith.

Fibrous-rooted annuals and perennials, stems usually branching monopodially, erect or trailing, internodes cylindrical, glabrous or variously vestite, often with a line of uniseriate hairs extending down one side.

Leaves with a tubular sheathing base; blade narrowly ovate to ovate (linear in *Tripogandra angustifolia*), usually flat but complicate in *T. purpurascens* and C-shaped or terete in *T. angustifolia*, usually fleshy, glabrous or variously vestite with uniseriate hairs, base cuneate, rounded, oblique, or amplexicaul, sometimes narrowed and subpetiolate, apex acute, sometimes acuminate; sheath glabrous to pilose, orifice glabrous or more often villous with long uniseriate hairs, usually with a line of uniseriate hairs extending down the side opposite the blade and continuing to the internode below.

Inflorescences composed of a single terminal or a terminal and a few axillary double cincinni, or a terminal panicle of double cincinni; peduncles with or without 1-2 lines of uniseriate hairs, otherwise glabrous to densely pilose, hairs uniseriate or capitate; pedicels erect or reflexed in fruit, glabrous to pilose, hairs uniseriate or capitate; bracts at the base of the pedicels small, a thin band of tissue which is glabrous to pilose with capitate or uniseriate hairs, margin entire, denticulate, with a few uniseriate hairs, or ciliate.

Flowers white to bright pink or magenta; sepals three, cymbiform, ovate, elliptic, or obovate, apex acute or obtuse, glabrous to pilose, margin hyaline, entire; petals three, ovate, elliptic, or obovate, with acute, rounded, obtuse, or irregular apex, deliquescing a few hours after anthesis to a shapeless mass; androecium actinomorphic in bud becoming zygomorphic at anthesis, composed of six stamens or three stamens and three staminodes in two whorls, the outer whorl always of stamens and opposite the sepals, shorter, with glabrous or variously bearded filaments about equalling the pistil; anthers extrorse in bud, becoming either introrse at anthesis or horizontal and then shedding pollen upward toward the stigma, dehiscing longitudinally,

connective usually short and inconspicuous, pollen usually fertile; inner whorl of stamens or staminodes opposite the petals, longer, filaments glabrous or variously bearded with uniseriate or moniliform hairs, variously curved and bent, two filaments bending at the base toward the third inner stamen-staminode around the filaments of the two outer intervening stamens so the inner stamens-staminodes are all in an erect position in front of the upper petal at anthesis, anthers dehiscing longitudinally, connective short and inconspicuous or elongate, straight or bent in a C- or U-shape, pollen fertile or sterile.

Ovary globose or cylindrical, somewhat flattened on three sides, glabrous, trilocular, placentation axile with two orthotropous ovules per locule, style shorter than the ovary, filiform, stigma simple, capitellate, or capitate.

Fruit a loculicidal capsule with persistent style; seeds usually 2 per locule (1 in *Tripogandra palmeri*, 1-2 in *T. grandiflora*), usually triangular, the surface variously reticulate or roughened, hilum punctiform, elliptic, or linear, embryotega dorsal, protuberant or impressed.

KEY TO THE SPECIES

a. Leaves terete or C-shaped in cross section, linear in outline. less than 2.7 mm wide, red or green; testa ribbed farinose. ..... 3. *T. angustifolia.*

a. Leaves flat or complicate, never terete, mostly broader than 3 mm, green. ..... b.

b. Nodes below the inflorescences bearing amplexicaul leaves; leaves flat, never complicate. ..... c.

c. Plants perennial; upper internodes pilose; hilum punctiform to elliptical. ..... 7. *T. encolea.*

c. Plants annual; upper internodes glabrous or with a line of uniseriate hairs; hilum linear. .... d.

d. Petals bright pink; plants tall, to 92 cm high; leaves of stem below amplexicaul leaves to 14.8 cm long, occasionally subpetiolate; peduncles pilose; seeds usually with an alveolate surface, convex dorsally. . 2. *T. amplexicaulis.*

d. Petals white or pale pink; plants shorter, to 58.5 cm high; leaves below amplexicaul leaves to 7.8 cm long, rounded or cuneate at the base; peduncles often glabrous; seeds never with alveolate surface, flattened dorsally. ..... 1. *T. amplexans.*

b. Nodes below the inflorescences without amplexicaul leaves or if amplexicaul then also complicate. .. e.

e. Filaments of inner (longer) staminal whorl glabrous. ..... f.

f. Sepals glabrous or nearly so; seeds two per locule, the upper larger, hilum linear, testa ribbed, areolate; inflorescence an open panicle. ..... 10. *T. guerrerensis.*

f. Sepals with scattered capitate hairs or pilose; seeds in each locule equal in size or only one per locule and then the margins revolute; inflorescence of double cincinni variously arranged but never in an open panicle. .. g.

g. Hilum linear, seeds one per locule with margin revolute; pedicel erect in fruit. ..... 15. *T. palmeri.*

g. Hilum punctiform, seeds usually 2 per locule, lacking revolute margins; pedicel reflexed in fruit. ..... h.

h. Leaf base oblique; testa reticulate but not ribbed; capsule obovoid, slightly stipitate. ..... 19. *T. silvatica.*

h. Leaf base not oblique, but instead cuneate to rounded; testa ribbed; capsule globose or obovoid, not stipitate. ..... i.

i. Testa prominently ribbed reticulate-foveate; longer filaments concave in upper third, to 3.3 mm long; seeds 0.8-1.4 mm long. .... 8. *T. glandulosa.*

i. Testa ribbed areolate; longer filaments inflated in upper portion, to 8.0 mm long; seeds 1.2-2.1 mm long. ..... j.

j. Calycine hairs long, some 1.5-4.5 mm long; leaves usually flat; peduncle usually glabrous; dorsal seed surface convex. .... 5. *T. disgrega.*

j. Calycine hairs short, the longest less than 1.0 mm long; leaves complicate; peduncle variously glabrous, pilose, with or without lines of hairs; dorsal surface of seed flat or concave. . k.

k. Internodes glabrous except for a line of uniseriate hairs down one side, rarely the upper internodes with scattered hairs. .... 16a. *T. purpurascens* subsp. *purpurascens.*

k. Internodes all with scattered capitate hairs and a line of uniseriate hairs down one side. . 16b. *T. purpurascens* subsp. *australis.*

e. Filaments of inner (longer) staminal whorl bearded, never glabrous. ..... l.

l. Hairs of the filaments uniseriate, never moniliform; hilum linear, testa farinose. .... 9. *T. grandiflora.*

l. Hairs of the filaments moniliform; hilum punctiform or elliptical. .... m.

m. Filaments of longer stamens inflated; leaf base subpetiolate, oblique; testa ribbed areolate, hilum elliptical. .... 4. *T. brasiliensis.*

m. Filaments of longer stamens terete, never inflated; leaf base various; testa not ribbed except *T. diuretica*, hilum punctiform (occasionally elliptical in *T. saxicola* and *T. diuretica*). ..... n.

n. Lamina of leaf cuneate or truncate at the base; petals white. ..... o.

o. Sepals pilose; pedicels pilose. .. p.

p. Pedicels erect in fruit; peduncles pilose with capitate hairs. ..... 11. *T. kruseana.*

p. Pedicels reflexed in fruit; peduncles glabrous except for 1-2 lines of uniseriate hairs. .... 17. *T. saxicola.*

o. Sepals nearly glabrous, with a few hairs at the point of union of adjacent sepals; pedicels glabrous, reflexed in fruit; peduncles glabrous except for 1-2 lines of uniseriate hairs. ..... 14. *T. neglecta.*

n. Lamina of leaf oblique at the base, rarely cuneate or rounded and then the petals bright pink; seeds trigonal, never lobed. ..... q.

q. Leaves subpetiolate at the base of the plant, to 4.4 cm long, to 1.85 cm wide; sepal midvein pilose; plants annual; seeds reticulate-foveate; bracts at the base of each pedicel with erose margin. .... 20. *T. warmingiana.*

q. Leaves never subpetiolate, to 14.5 cm long, to 3.5 cm wide; plants perennial; sepals glabrous to pilose, the midvein not distinctively vestite; seeds ribbed, reticulate-

foveate, or reticulate; bracts various. ..... r.
r. Style nearly as long as the ovary, 0.6-1.1 mm long; testa of seeds ribbed areolate-foveate; sepals 4.5-7.0 mm long. ..... 6. *T. diuretica.*
r. Style much shorter than the ovary, 0.15-0.6 mm long; testa of seeds reticulate or reticulate-foveate, never ribbed; sepals 1.8-6.0 mm long. ..... s.
s. Testa reticulate-foveate; peduncles pilose (rarely glabrous or with 2 lines of hairs); ovary 0.5-1.0 mm long; sepals 1.8-4.0 mm long; outer anthers 0.3-0.6 mm long. . 13. *T. multiflora.*
s. Testa reticulate; peduncles glabrous or with 1-2 lines of hairs, rarely pilose, if pilose then ovary 1.2-1.7 mm long; sepals 4.0-6.0 mm long and outer anthers 0.8-1.8 mm long. ..... t.
t. Seed surface uniformly brown; sepals narrowly ovate, elliptical, or obovate, 4.0-6.0 mm long, 1.6-2.8 mm wide; peduncles 0.7-12.7 cm long; inner filaments 4.5-7.5 mm long, densely bearded; petals bright pink or magenta, 5.5-11.0 mm long; ovary 1.2-1.7 mm long; style 0.2-0.6 mm long. .. 12. *T. montana.*

t. Seed surface gray or brownish with lighter reticulations; sepals ovate, 2.5-4.6 mm long, 1.3-2.7 mm wide; peduncles 0.4-5.1 cm long; inner filaments 2.7-4.5 mm long, variously bearded; petals white or pink, 3.5-6.2 mm long; ovary 0.6-1.3 mm long; style 0.1-0.3 mm long. . . . . 18. *T. serrulata.*

1. **Tripogandra amplexans** Handlos, *sp. nov.* HOLOTYPE: **México.** MICHOACAN: Km. 201.2 of Hwy. 15, 8.1 km. north of Tuxpan, 1920 m., 18 Sept. 1967, *Handlos* 428 (US!).

Herba annua; *caulis* erectus, usque ad 58.5 cm altus, internodiis infra folia amplexicaulia usque ad 10.5 cm longis. *Folia* ovata, laminis usque ad 7.8 cm longis, usque ad 3.4 cm latis, inferis basi cuneatis, superis amplexicaulis, glabris, margine ciliatis, apice acutis, vaginis usque ad 10.5 mm longis, usque ad 7.7 mm diam., glabris vel linea unica pilorum instructis. *Inflorescentiae* simplices vel paniculatae ex 1-8 cincinnis duplicibus constantes, 1-5 foliis amplexicaulibus et 0-4 bracteis vaginantibus subtentae; *pedunculi* usque ad 6.8 cm longi, glabri vel pilis paucis dispersis, distalibus, capitatis instructi; *cincinni* duplices alabastra, flores, vel fructus usque ad 12 gerentes; *pedicelli* usque ad 7.0 mm longi, pilis capitatis pilosi, erecti vel maturitate effusi, bracteis basi pedicellorum margine integris, glabris vel pilis paucis, dispersis, capitatis pubescentibus. *Flores* albi vel subrosei; *sepala* ovato- vel elliptico-cymbiformia, 2.5-5.0 mm longa, 1.2-2.2 mm lata, pilis paucis, dispersis, capitatis, incoloribus instructa, margine integra et hyalina, apice acuta, rotundata vel obtusa;

petala late ovata vel ovato-elliptica, 4.2-8.0 mm longa, 3.9-6.5 mm lata, apice acuminata, acuta, vel obtusa; *stamina* 3, sepalis opposita (Fig. 25), filamentibus 1.0-2.2 mm longis, albis, dorsaliter medio 0-7 pilis albis, incoloribus vel subroseis, moniliformibus pubescentibus (Fig. 6), antheris 0.3-1.0 mm longis, 0.3-1.0 mm latis, albis, polline albido; *staminodia* 3, petalis opposita (Fig. 25), filamentibus epipetalis, 2.0-6.0 mm longis, albis, glabris, sigmoideis et distaliter dilatis (Fig. 26), antheris luteis, 0.2-1.0 mm longis, 0.3-1.0 mm latis, connectivo C- vel V-formi, polline luteo; *ovarium* 0.8-1.5 mm longum, 0.7-1.2 mm diam., glabrum, stylo 0.3-0.8 mm longo, stigmate simplici vel capitellato. *Capsula* globosa, 2.7-3.5 mm longa, glabra, seminibus triangularibus raro trapezoideis (Figs. 58, 59), 1.2-1.8 mm longis, costatis, areolatis, hilo lineari (Fig. 60).

Chromosome number: $n=16$.

Distribution and habitat: western México in the states of Jalisco, Michoacán, México, Morelos, and Guerrero; in damp, rocky places in nearly neutral soil at elevations from 800-2200 m.

Flowering: This species begins flowering in the rainy season from early August and continues until October. Flowers open from 8:00 AM to 9:00 AM and close between 10:30 AM and 12:50 PM. In the field these annuals exhibit a great deal of variation with regard to size when flowering. This is probably due to the amount of moisture available after germination, the effects of grazing, and the fertility of the soil.

REPRESENTATIVE SPECIMENS

México. JALISCO: barranca SE of Ciudad Guzman, 22 Oct. 1940, *Moore, Jr.* 158 (BH, GH). MICHOACÁN: Zitácuaro, Dist. Zitácuaro, 1950 m., 6 Sept. 1938, *Hinton et al.* 13198 (ARIZ, GH, MICH, MO, NY, US). MEXICO: just N of bridge, Puente Calderón, ca. km. 135 of Hwy. 55, just north of Ixtapan de la Sal, 6 Aug. 1967, *Handlos* 312 (BH). MORELOS: railroad from Mexico City to Cuernavaca at km. 96; region of El Parque, ca. 2200 m., 5 Oct. 1958, *Hawkes, Hjerting & Lester* 1623 (C, F). GUERRERO: Manchon, Dist. Mina, 1290 m., 13 Aug. 1936, *Hinton et al.* 9206 (ARIZ, GH, NY, US).

The range of *Tripogandra amplexans* is of special interest because it is wholly within the range of the more widespread and similar *T. amplexicaulis*. In many locations the two species occur together. I am unable to discern any differences in habitat preferences for these two species.

The main reasons for considering these plants as two distinct species, aside from morphological differences, are their occurrence together with little evidence of hybridization and the presence of a partial isolating mechanism in the slightly different flowering seasons.

A list of distinguishing characteristics is presented here to summarize the differences between the species. *Tripogandra amplexans* is generally smaller in stature (to 58.5 cm tall), has smaller leaves (to 7.8 cm long, to 3.4 cm wide) which are rounded or cuneate at the base, a smaller inflorescence composed of fewer (to 8) double cincinni, a glabrous peduncle, flowering period from August to October, fewer flowers (to 12 per double cincinnus), which have smaller white or pale pink petals (to 8.0 mm long), seeds with larger, smoother ribs, a deeply impressed embryotega and a flatter dorsal surface.

Tripogandra amplexicaulis can be recognized by its taller stature (to 92 cm tall), its larger leaves (to 14.8 cm long, 5.0 cm wide), a narrowed, subpetiolate laminar base in some populations, a large paniculate inflorescence composed of up to 14 double cincinni, a pilose peduncle, flowering period from mid-August to December, more flowers per inflorescence (to 18), larger petals (to 13.0 mm long), flowers bright pink, seeds with an alveolate surface, finer ribs, a slightly impressed embryotega and convex dorsal surface.

There may be evidence of hybridization between these two species because at Puente Calderón in the state of México I found one plant that was vegetatively like *Tripogandra amplexans* with small flowers but showing the bright pink color of *T. amplexicaulis*. Other genetic

mechanisms could explain the flower color difference but for the moment the problem has not been resolved.

A few plants have been collected which exhibit characteristics of both species and can only arbitrarily be placed in either species (Figs. 29, 62. 63). Of these intermediate collections, five are from the known margins of the range, while one collected from a road cut on a steep hillside and another from a lava field represent populations existing in disturbed habitats. Further investigations should be conducted to determine whether these plants represent stabilized hybrids, populations with introgression into one or the other of the parental species, specialized peripheral populations, or whether some other explanation of their intermediacy is plausible. A list of the collections which appear intermediate follows.

SPECIMENS EXAMINED

México. JALISCO: ca. km. 781.2 of Hwy. 15, Guadalajara to Tepic, ca. 25 km. NW of Magdalena, 1000 m., 6 Oct. 1967, *Handlos* 451 (BH); km. 1050 of Hwy. 80, 14 km. SW of Autlán, 1120 m., 4 Oct. 1967, *Handlos* 442 (BH). MEXICO: Rincón del Carmen, Dist. Temascaltepec, 1340 m., 16 Sept. 1932, *Hinton* 1745 (BM). MORELOS: lava fields near Yautepec ('Yantepec'), 4500 ft., 22 Oct. 1902, *Pringle* 8697 (BM, C, F, GH, GOET, M, MEXU, MO, MSC, NY, PH, POM, UC, US). GUERRERO: Rincón Viejo, 800 m., 17 Oct. 1963, *Kruse* 898 (MEXU); Hwy. 95 between Ocotito and Tierra Colorado, 680 m., 21 Sept. 1967, *Handlos* 434 (BH); Parotas, Dist. Mina, 800 m., 12 Sept. 1936, *Hinton et al.* 9504 (ARIZ).

2. **Tripogandra amplexicaulis** (Klotzsch ex Clarke) Woodson, Ann. Missouri Bot. Gard. 29:152. 1942.

Tradescantia amplexicaulis Klotzsch ex Clarke in DC., Monographiae Phanerogamarum 3:304. 1881. TYPE: **México.** Chiapas, etc. Sept. 1864-70. *Ghiesbreght* 887 (Lectotype, K; isolectotype, GH!).

Tradescantia dilatata Clarke in DC., Monographiae Phanerogamarum 3:304. 1881, *nom. nud. pro syn.*

Tradescantia umbellata Pavon ex Clarke in DC., Monographiae Phanerogamarum 3:304. 1881, *nom. nud. pro syn.*

Descantaria amplexicaulis (Klotzsch ex Clarke) Brückner, Notizbl. Bot. Gart. Berlin-Dahlem 10:56. 1927.

Plants annual; stem erect, to 92 cm tall, unbranched or branching profusely at the base, occasionally decumbent basally and rooting at the nodes; internodes below the inflorescence to 11.2 cm long, glabrous in the upper part of the plant or with a complete or partial line of uniseriate hairs extending down the stem from the sheath above on the side opposite the blade. Leaves narrowly ovate to ovate; blades to 14.8 cm long, to 5.0 cm wide, glabrous on both sides, base of variable shape, always amplexicaul below the inflorescence, at the base of the plant either cuneate, rounded, or narrowed and then appearing petiolate, margin ciliate, apex acuminate, or less often, acute; sheaths to 16.5 mm long, to 11.2 mm in diam., upper ones completely glabrous, lower ones with a few long uniseriate hairs at the orifice, and a complete or partial line of uniseriate hairs extending down the side opposite the blade. Inflorescences terminating each stem, composed of a single double cincinnus or paniculate with up to 14 double cincinni, 1-6 amplexicaul leaves and 0-4 sheathing bracts, cincinni borne terminally and in the axils of the upper bracts and amplexicaul leaves; peduncles to 9.1 cm long, green and/or red, pilose distally, or rarely with only a few scattered capitate hairs with the lowest cell enlarged; double cincinni with up to 13 (-18) buds, flowers and/or fruits; pedicels 3.0-7.3 mm long, to 1.0 mm in diam., erect or spreading in fruit, green or red with a green base, pilose, hairs capitate; bracts at the base of each pedicel pilose or with scattered capitate hairs, margin entire. Flowers bright pink; sepals ovate-cymbiform, 4.0-6.1 mm long, 1.5-3.0 mm wide, green with a darker tip and midvein, or green with a red base and margin, or red, with scattered capitate hairs, margin entire and hyaline, apex more or less acute; petals ovate to broadly ovate, 6.0-13.0 mm long, ca. 3.4-11.5 mm wide, base cuneate, apex acuminate or rounded; stamens 3, opposite the sepals, filaments 1.1-2.0

mm long, pink, bearing a few (5-10) pink, moniliform hairs in two rows in the middle of the dorsal side (Fig. 7), anthers 0.8-1.8 mm long, 0.5-1.8 mm wide, whitish with a pink or magenta line around the more or less parallel anther sacs, dorsifixed, versatile, pollen whitish; staminodes 3, opposite the petals, filaments 3.5-8.0 mm long, slightly epipetalous, pink proximally, white distally, glabrous, inflated in the distal third just below the anthers (Fig. 23), bent in an S-shape; anthers 0.7-2.2 mm long, 0.7-2.2 mm wide, dorsifixed, connective yellow, V-shaped, with yellow, elongate more or less parallel anther sacs, pollen sterile, yellow; ovary 0.6-1.4 mm long, 0.7-1.3 mm in diam., white, glabrous, style 0.3-0.7 mm long, stigma simple or capitellate. Capsule 3.1-4.5 mm long, 2.5-4.0 mm in diam., green or brown, glabrous; seeds 2 per locule, triangular, 1.4-2.2 mm long, dark brown or black, testa areolate, sometimes alveolate (Figs. 64, 65), with ribs radiating from the embryotega (Fig. 66), hilum linear (Figs. 65, 67).

Chromosome number: $n=16$.

Distribution and habitat: Sonora to Chiapas, México and Guatemala; at elevations from (300-) 600 to 2150 m in thin layers of slightly acid soils which range from clay to sandy loam, or humus.

Flowering: Flowering in the native habitat occurs from mid-August through December; most flowering collections seem to have been made in September and October. In México and Ithaca, N.Y., flowers open before 8:00 AM and close between 11:30 AM and 12:50 PM.

REPRESENTATIVE SPECIMENS

México. SONORA: Sierra Charuco, Río Mayo, 10 Sept. 1935, *Gentry* 1706 (ARIZ, F, GH, MO, UC, US). CHIHUAHUA: Guayanopa Canyon, Sierra Madre Mts., 23 Sept. 1903, *Jones* (POM). SINALOA: 16.3 miles S.W. of El Paraíso, on road between Villa Unión and El Salto, 27 Sept. 1953, *Ownbey & Ownbey* 1903 (F, MICH, NY, UC, US). DURANGO: La Bajada, Tamazula, 300-600 m., Nov. 1921, *Ortega* 4349 (US). NAYARIT: hills back of Jalisco, 11 Nov. 1925, *Ferris* 5981 (DS). JALISCO: km. 69 of Hwy. 41, N of Guadalajara, 5 Oct. 1967, *Handlos* 448 (BH). MICHOACAN: 11 miles below Uruapan, kms. 95-

96, on road to Apatzingán, 1160 m., 11 Sept. 1961, *Moore, Jr. & Bunting* 8750 (BH, MEXU, UC). MEXICO: Rincón del Carmen, Dist. Temascaltepec, 2 Dec. 1935, *Hinton et al.* 8762 (ARIZ, GH, MICH, NY, US). MORELOS: km. 125.3 of Hwy. 95D, 6.2 km. west of bridge over Río Amacuzac, ca. 1200 m.. 21 Sept. 1967, *Handlos* 431 (BH). PUEBLA: Barranca de Chochonotla, Municipio de la Unión, 4 km. al E. de Xicotepec de Juárez, 27 Sept. 1964, *González Quintero* 1674 (MICH, MSC). GUERRERO: Cañon del Mano, railroad tracks north of Iguala, ca. 3 km. N of El Naranjo, ca. 840 m., 13 Sept. 1967, *Handlos* 417 (BH). CHIAPAS: along Hwy. 190 in the Zinacantán paraje of Muctajoc, Municipio of Ixtapa, 3500 ft., 26 Oct. 1965, *Breedlove* 13797 (DS, F, MEXU). **Guatemala.** HUEHUETENANGO: along road between San Sebastián H. and San Rafael Pétzal, 1900-2000 m., 14 Aug. 1942, *Steyermark* 50537 (F). GUATEMALA: 1939, *Aguilar* 374 (F). JALAPA: mountains about Chahuite, northwest of Jalapa, about 1650 m., 16 Nov. 1940, *Standley* 77472 (F). SANTA ROSA: Cenaguilla, 4000 ft., Dec. 1892, *Heyde & Lux* 4284 (GH, M, NY, US). JUTIAPA: hills between Jutiapa and Plan de Urrutia, north of Jutiapa, 900-1200 m., 28 Oct. 1940, *Standley* 75525 (F).

The history of the name *Tripogandra amplexicaulis* and the specimens associated with it must be considered to understand its present application. In the original description, Clarke (1881) credits Klotzsch for the name *Tradescantia amplexicaulis* in the following fashion, "(Klotzsch ms. in herb. Berol.)". As the Berlin herbarium was largely destroyed during World War II it is not possible to examine the specimens that Klotzsch may have seen. However, type specimens of the Commelinaceae in the basement of the Berlin herbarium did not burn (Pilger, 1957) and among them is a specimen labelled "typus!" collected by C. Ehrenberg in "Mejico" and annotated as *Tradescantia amplexicaulis* by C. B. Clarke in his own hand. This may be the specimen Klotzsch would have designated as the type for his name. Klotzsch never published his description so this specimen has no standing under the current rules. Clarke does not mention the specimen in his description of the species. The Ehrenberg specimen represents *Tripogandra amplexans*. Clarke listed eight collections of *Tradescantia amplexicaulis* (*Schaffner* 108, 138; *Botteri* 531, 892; *Ghiesbreght* 887; *Salvin; Savage; Hoffman*) which are syntypes because no holo-

type was designated. Additionally he cited *Tradescantia umbellata* Pavon as a synonym and I have seen one specimen so labelled from the British Museum and annotated by Clarke as *T. dilatata*, his manuscript name for *T. amplexicaulis*.

The Pavon specimen (*T. umbellata*), *Schaffner* 108, and *Botteri* 531 represent *Tripogandra purpurascens*. *Botteri* 892 and *Ghiesbreght* 887 represent the taxon presently under consideration and the remaining specimens have not been seen. The original description given by Clarke does not overwhelmingly refer to any one species. To preserve current usage of the name *T. amplexicaulis* I therefore designate *Ghiesbreght* 887 (K) as the lectotype for *T. amplexicaulis*. The following phrases from Clarke's description are taken as referring to *T. amplexicaulis* sensu stricto and distinguishing it from *T. purpurascens*. "Pedunculis quasi paniculam efformantibus, . . . Folia . . . acuminata, . . . vaginae ore glabratae; folia summa fere ad vaginas reducta. . . . fructus tempore patenti-erecta." The remainder of Clarke's original description could apply to both species. I do not understand his statement, "Ovarium apice vix aut minute pubescens." I have never seen hairs on the ovary of any specimens of *Tripogandra*.

In the past *Tripogandra amplexicaulis* and *T. amplexans* have been considered the same species. I prefer to separate them on the basis of a number of morphological characters, a difference in flowering season and the fact that I have found both species growing side by side with little or no evidence of hybridization as discussed under *T. amplexans*.

3. **Tripogandra angustifolia** (Robinson) Woodson, Ann. Missouri Bot. Gard. 29:152. 1942.

Tradescantia angustifolia Robinson, Proc. Amer. Acad. Arts 27:185. 1893. TYPE: **México.** SAN LUIS POTOSI: Las Canoas, 14 Aug. 1891, *Pringle* 3902. (Holotype, GH!; isotypes. B!, BM!, BR!, E!, GOET!, M!, MO!, MSC!, NY!, PH!, UC!).

Descantaria angustifolia (Robinson) Brückner, Notizbl. Bot. Gart. Berlin-Dahlem 10:56. 1927.

Ilustrations: Matuda, Anales Inst. Biol. Nac. México 26:368. 1956 ('1955').

Plants annual; stem erect, to 24 cm tall, unbranched or branched; internodes to 5.0 cm long, green or red, glabrous except for a line of uniseriate hairs extending straight down the side opposite the leaf blade from the sheath above. Leaves linear; blades to 7.1 cm long, 2.7 mm wide, terete or C-shaped in cross section, glabrous dorsally and ventrally, margin usually ciliate in the proximal portion or occasionally to the tip, acute at the apex; sheaths to 4.1 mm long, to 4.0 mm in diam., with a few long uniseriate hairs at the orifice, otherwise glabrous except for a line of uniseriate hairs extending down the side opposite the lamina. Inflorescences composed of 1-4 double cincinni borne terminally and in the axils of the upper leaves; peduncles to 7.5 cm long, green or red, glabrous or sometimes with 1-2 lines of uniseriate hairs extending down one side; buds, flowers and/or fruits 2-10 per double cincinnus; pedicels to 8.0 mm long, to 0.6 mm in diam. at anthesis, green or red, glabrous, erect in fruit; bracts at the base of each pedicel glabrous, margin entire, erose, or sometimes ciliate, lowest 1-2 bracts sometimes leaf-like. Flowers pink, occasionally white; sepals elliptic- or ovate-cymbiform, to 4.5 mm long, to 2.0 mm wide, green, green with a darker tip, or red, glabrous, margin entire, hyaline, apex acute; petals broadly ovate, to 5.0 mm long, to 4.0 mm wide, cuneate basally, apex acute; stamens 3, opposite the sepals, filaments to 1.5 mm long, white or pink, nearly glabrous except for a few minute hairs, anthers 0.3-0.8 mm long, 0.4-0.7 mm wide, pink, connective bent in the middle and U-shaped with the anther sacs parallel (Fig. 14), pollen white; staminodes 3, opposite the petals, filaments epipetalous, to 4.0 mm long, pink and/or white, glabrous, bent in an S-shape distally (Fig. 30), anthers 0.7-1.1 mm long, 0.7-1.1 mm wide, versatile, connective yellow, promi-

nent, C-, U- or V-shaped, with the yellow anther sacs divergent (Fig. 27), pollen white, cream, or yellow, sterile; ovary 0.5-1.0 mm long, 0.4-1.0 mm in diam., green, glabrous, style 0.3-0.7 mm long, stigma simple or capitellate. Capsule globose, 2.0-3.0 mm long, 1.5-2.4 mm in diam., brown, glabrous; seeds 2 per locule, triangular, 0.9-1.3 mm long, brown or gray, testa ribbed farinose (Fig. 74), hilum punctiform (Fig. 75), embryotega impressed.

Chromosome number: $n=8$.

Distribution and habitat: central and southern México and western Guatemala from the states of San Luis Potosí, west to Guerrero and south to Chiapas in México and the department of Huehuetenango in Guatemala; in thin alkaline soil on limestone cliffs and ledges.

Flowering: In the native habitat, flowering occurs in August through October. In a uniform environment, plants collected at different locations flower at different times, probably indicating physiological variation in response to differing environmental factors in the various localities. Flowers open between 7:00 AM and 8:15 AM — earlier in sunny locations and later in shady locations. Closing occurs between 11:00 and 11:30 AM.

REPRESENTATIVE SPECIMENS

México. SAN LUIS POTOSI: Pozo de Azuña, 15 km. al E. de Guadalacázar, 1450 m., 26 Sept. 1955, *Rzedowski* 6695 (MEXU, MICH). HIDALGO: between Jacala and Barranca Seca via Hilo Juanico, Dist. Jacala, 1400-1600 m., 30 Oct. 1946, *Moore, Jr.* 1800 (BH, GH). VERACRUZ: Baños del Carrizal, Aug. 1912, *Purpus* 6174 (F, GH, MO, NY, UC, US). MEXICO: rounded hill with crater in the center about 0.5 km. N. of village of Tonatico, 23 Aug. 1965, *Handlos* 169 (BH). MORELOS: near Yautepec, Aug. 1903, *Rose & Painter* 6575 (GH). PUEBLA: km. 298.3 of Hwy. 190, ca. 12.8 km. south of Acatlán, 1340 m., 11 Sept. 1967, *Handlos* 406 (BH). GUERRERO: km. 231.6-7 of Hwy. 95, 37.7 km. north of Chilpancingo, 30 Aug. 1967, *Handlos* 388 (BH). OAXACA: Cerro de San Antonio de la Cal, 1700 m., 18 Aug. 1907, *Conzatti* 1995 (F, MICH). CHIAPAS: km. 1062.5 of Hwy. 190, 4 km. south of Berriozabal, 930 m., 18 Aug. 1967, *Handlos* 364 (BH). **Guatemala.** HUEHUETENANGO: dry slopes between San Ildefonso Ixtahuacán and Cuilco, 1350-1600 m., 16 Aug. 1942, *Steyermark* 50694 (F, MO, US).

Tripogandra angustifolia is unique for its narrow leaves which are nearly terete or C-shaped in cross-section. These leaves are probably a special adaptation which allows the plants to store water between rains and grow in very dry areas. Small plants can survive and produce seeds with as few as three or four leaves and two to four flowers in a single terminal inflorescense. To illustrate how densely plants of *T. angustifolia* grow, in 1967 I arbitrarily selected an area of 100 square cm, ten cm to a side. I carefully removed each plant and discovered there were exactly 240 plants in that area! Each plant was surviving on an average of 0.416 square cm of space.

This species seems to be the only one possessing very short hairs on the staminal filaments. These obscure hairs may indicate that the ancestor of *Tripogandra angustifolia* had a bearded filament and that as an adaptation for water conservation these structures were reduced but not completely lost.

The seeds of *Tripogandra angustifolia* are distinctive for their triangular outline and the conspicuously ribbed sides. Maintenance of this species in cultivation has proved a problem because seed germination has been very low. Field-collected seeds have produced one or two or no seedlings at all where seeds nearly covered the surface of a pot of soil. This contrasts with conditions in México where plants grow in very dense stands, implying a high percentage of seed germination.

Tripogandra angustifolia is morphologically very uniform throughout its range which extends for some 1270 km from north to south. The variations which occur — white or pink flowers, red or green stems or leaves — occur within a population and do not distinguish one population from another. One or two leaf-like bracts occur rarely at the base of an inflorescence and may indicate an ancestral inflorescence similar to that of present day *Tradescantia* which has large leaf-like bracts. There are slight variations in intensity of flower color and petal shape in plants

from different populations, but the significance of these variations is unknown. The general lack of morphological variation may be due to the specialized and uniform habitat which this species inhabits — the thin layer of alkaline soil found in cracks or on ledges of limestone rock throughout southern México and parts of Guatemala — where it seems to be specially adapted to survive. As soil depth increases, other species of plants seem to be better adapted to compete and *T. angustifolia* is crowded out.

4. **Tripogandra brasiliensis** Handlos, *sp. nov.* HOLOTYPE: **Brazil.** MARANHAO: "Ilha de Balsas" region, between the Balsas and Parnaíba Rivers. Ca. 6 km. north of main house of Fazenda "Morros", ca. 30 km. south of Lorêto, ca. 300 m., 30 April 1962, *Eiten & Eiten* 4458 (NY!).

Herba annua(?); *caulis* erectus, usque ad 52.5 cm altus, internodiis usque ad 13.4 cm longis, linea unica pilorum instructis, aliter glabris vel pilis dispersis pubescentibus. *Folia* angusto-ovata, petiolata, laminis usque ad 8.7 cm longis, usque ad 2.1 cm latis, apice acuminatis, basi obliquis, margine ciliatis, dorsaliter pilosis vel pilis dispersis instructis, ventraliter glabris praeter lineam unicam pilorum secus costam, vaginis usque ad 6.0 mm longis, usque ad 3.6 mm diam., orificio villosis, linea unica pilorum instructis, aliter glabris vel pilis dispersis praeditis. *Inflorescentiae* terminales et in axillis foliorum summorum, ex 1-2 cincinnis duplicibus constantantes; *pedunculi* usque ad 3.9 cm longi, pilis paucis dispersis pubescentes; *pedicelli* usque ad 3.0 mm longi, glabri, bracteis basi pedicellorum glabris, margine integris. *Flores* albi; *sepala* ovato-cymbiformia, usque ad 4.2 mm longa, usque ad 2.7 mm lata, glabra vel 1-2 pilis instructa, margine hyalina, apice obtusa; *petala* non visa; *stamina* 6 in verticillis duobus, 3 sepalis opposita filamentibus brevis, usque ad 1.5 mm longis, glabris, antheris usque ad 0.7 mm longis, usque ad 0.6 mm latis, 3 petalis opposita filamentibus longioribus, usque ad 3.9 mm longis, dilatatis et barbatis distaliter,

antheris usque ad 0.4 mm longis, usque ad 0.9 mm latis, connectivo elongato; *ovarium* usque ad 1.5 mm longum, usque ad 1.0 mm diam., glabrum, stylo usque ad 0.3 mm longo, stigmate simplici. *Capsula* globosa, usque ad 3.2 mm longa, usque ad 3.3 mm diam., glabra, seminibus triangularibus, usque ad 2.0 mm longis, costatis, areolatis (Fig. 47), hilo elliptico (Fig. 48).

Vernacular name: baixão do cipó, fide Eiten & Eiten.

Distribution: known from only three locations in Maranhão and Minas Gerais, Brazil. The habitat of this species, according to Eiten and Eiten, was tall forest along a gully in a disturbed area with a pronounced dry season and intermittent streams.

SPECIMENS EXAMINED

Brazil. MARANHAO: 30 April 1962, *Eiten & Eiten* 4458 (NY). MINAS GERAIS: Lagoa Santa, *Warming* (F p.p., US p.p.); Lagoa Grande, Belo Horizonte, Mar. 1935, *Cocheau* (R).

This species is recognizable from its probable annual habit, petiolate leaves, peduncle with scattered uniseriate hairs, an inflated filament on the longer stamens, and the large ribbed areolate seeds with elliptical hilum. While the collections known to me are few, the species is undoubtedly distinct from other South American species of *Tripogandra*.

5. **Tripogandra disgrega** (Kunth) Woodson, Ann. Missouri Bot. Gard. 29:152. 1942.

   Tradescantia disgrega Kunth, Enumeratio Plantarum 4:97. 1843. TYPE: **México.** Serro Colorado, Aug. 1828, *Schiede* 974 (816) (Lectotype, B!; isolectotype, HAL!).

   Tradescantia ehrenbergiana Klotzsch ex Clarke in DC., Monographiae Phanerogamarum 3:305. 1881, *nom. nud. pro syn.*

   Disgrega mexicana Hasskarl ex Clarke in DC., Monographiae Phanerogamarum 3:305. 1881, *nom. nud. pro syn.*

Descantaria disgrega (Kunth) Brückner, Notizbl. Bot. Gart. Berlin-Dahlem 10:57. 1927.

Tradescantia disgrega forma *glandulosa* Standley & Steyermark, Field Mus. Nat. Hist., Bot. Ser. 23:36. 1944. HOLOTYPE: **Guatemala.** ZACAPA: Sierra de las Minas, along trail between Río Hondo and summit of mountain at Finca Alejandria, 1000-1500 m., 11 Oct. 1939. *Steyermark* 29751 (F!); photograph (F!).

Tradescantia disgrega forma *pubescens* Standley & Steyermark, Field Mus. Nat. Hist., Bot. Ser. 23:37. 1944. HOLOTYPE: **Guatemala.** GUATEMALA: Borraja, 1085 m., Oct. 1928, *Morales R.* 1106 (F!); photograph (F!).

Tripogandra disgrega forma *glandulosa* (Standley & Steyermark) Standley & Steyermark, Fieldiana: Bot. 24(3):37. 1952.

Tripogandra disgrega forma *pubescens* (Standley & Steyermark) Standley & Steyermark, Fieldiana: Bot. 24(3):37. 1952.

Plants annual, rooting at lower nodes; stem erect, to 55 cm tall, branched or unbranched, some plants with the lowermost portion decumbent; internodes to 12.5 cm long, pilose or glabrous except for a line of uniseriate hairs extending down the side of the stem, continuous with the line on the sheath above. Leaves narrowly ovate to ovate; blades to 9.8 cm long, 3.8 cm wide, cuneate, rounded, or subpetiolate at the base, glabrous to pilose on both sides, the uppermost leaf usually with fewer or no hairs, margin ciliate, apex acute or acuminate; sheaths to 15.0 mm long, 4.3 mm in diam., villous at the orifice, a line of uniseriate hairs extending down the side opposite the blade, otherwise glabrous to pilose. Inflorescences composed of 1-5 double cincinni borne terminally and in the axils of the upper leaves; peduncles to 9.5 (-15) cm long, glabrous or with a few capitate hairs near the distal end; double cincinni with up to 25 buds, flowers and/or fruits; pedicels to 7.0 mm long, glabrous proximally but pilose distally,

reflexed in fruit; bracts at the base of each pedicel pilose or with scattered capitate hairs, margin entire. Flowers pink; sepals ovate- or elliptic-cymbiform, to 6.0 mm long, 3.0 mm wide, green or with red at the tip and/or base, pilose or with scattered capitate hairs 1.5-4.5 mm long, margin hyaline, apex more or less acute; petals broadly ovate, to 8.0 mm long, to 7.0 mm wide, base cuneate, apex acuminate; stamens 6, in two whorls, the outer shorter, filaments to 2.0 mm long with a few (ca. 10) moniliform hairs borne on the middle of the dorsal side, anthers 0.7-1.6 mm long, 0.5-1.4 mm wide, dorsifixed, versatile, with anther sacs slightly spreading (not parallel); stamens of the inner whorl longer, filaments to 8.0 mm long, glabrous, with a U- or open S-shaped bend and inflated in the upper half, anthers to 1.5 mm long, to 1.6 mm wide, basifixed, connective conspicuous, anther sacs either divergent or becoming parallel and adjacent through bending of the connective in a U-shape; ovary to 1.1 mm long, to 1.3 mm in diam., glabrous, style 0.4-0.7 mm long, stigma simple or capitellate (minutely penicilliform). Capsule globose, to 3.5 mm long, to 3.5 mm in diam., green or brown at maturity, glabrous; seeds 2 per locule, triangular or rarely elliptical, 1.2-1.7 mm long, brown to black, testa areolate, with ribs (sometimes obscure) radiating from the embryotega (Fig. 52), hilum punctiform (Fig. 53).

Vernacular name: yerba del pollo fide Hinton.

Distribution and habitat: from Jalisco to Chiapas, México, Guatemala, Honduras and El Salvador; in moist areas along streams or in pine forests, occasionally a weed in cornfields.

Flowering: This species flowers from August to November in different parts of México, and from October to February in Guatemala. The flowers open before 8:45 AM and begin closing about 11:25 AM.

REPRESENTATIVE SPECIMENS

México. JALISCO: Sierra del Tigre, 3 miles south of Mazamitla, 2100-2200 m., 22 Sept. 1952, *McVaugh* 13167 (MICH). HIDALGO: vicinity of Molango on Lolotla road, Municipality Molango, District

Molango, 1600 m., 9 Nov. 1946, *Moore, Jr.* 1984 (BH). VERACRUZ: Orizaba, *Botteri* 326 (GH). MICHOACAN: roadsides in pine zone about 48 kms. from Pátzcuaro on road to Tacámbaro, ca. 6-7000 ft., 2 Sept. 1948, *Moore, Jr. & Wood, Jr.* 4847 (BH). MEXICO: Ypericones, Dist. Temascaltepec, 23 Nov. 1935, *Hinton et al.* 8718 (GH, MICH, MO, NY). MORELOS: in pine forest, km. 61, off Cuernavaca-Mexico City Highway, 2 Oct. 1943, *Lundell & Lundell* 12496 (MICH, NY, UC). OAXACA: 15 km. al S. de Sola de Vega, sobre la carretera a Puerto Escondido, 1800 m., 30 Sept. 1965, *Rzedowski* 21296 (MICH). CHIAPAS: sitio in San Cristóbal las Casas, Municipio of San Cristóbal las Casas, 7100 ft., 20 Sept. 1965, *Breedlove* 12310 (DS). **Guatemala.** SAN MARCOS: barrancos 6 miles south and west of town of Tajumulco, northwestern slopes of Volcán Tajumulco, 2300-2800 m., 26 Feb. 1940, *Steyermark* 36621 (F). CHIMALTENANGO: above Las Calderas, 1800-2100 m., 15 Dec. 1938, *Standley* 60014 (F). SACATEPEQUEZ: Ciudad Vieja, Nov. 1914, *Tejada* 301 (US). GUATEMALA: near San Juan Sacatepéquez, about 1800 m., 8 Dec. 1938, *Standley* 59258 (F). SANTA ROSA: Santa Rosa, 3000 ft., Nov. 1892, *Heyde & Lux* 4285 (GH, NY, US). **Honduras.** MORAZAN: colinas cultivadas de maíz de la Montañita, 1500 m., 18 Nov. 1948, *Molina R.* 1610 (GH, US). EL PARAISO: slopes above Yuscarán, Montserrat, 1500 m., 25 Nov. 1958, *Hawkes, Hjerting & Lester* 2061 (C, K). **El Salvador.** SANTA ANA: Hda. Los Planes nördl. Metapán, 1800 m., 29 Oct. 1950, *Rohweder* 707 (F). MORAZAN: eastern edge, finca of General J. T. Calderón, Montes de Cacaguatique, ca. 1340 m., 28 Dec. 1941, *Tucker* 646 (BH p.p., F p.p., MICH p.p., MO, NY p.p., PH p.p., UC p.p., US p.p.).

Schlechtendal (1831) described but did not name a plant of *Tripogandra disgrega* from a specimen (*Schiede* 974 (815)) housed at Halle. Kunth later named the species and his description was drawn from a duplicate specimen of Schiede's housed in Berlin "(Descr. juxta specimen Schiede.)". In all respects the description and specimen are in accord. I have seen two sheets of this collection and because there is no evidence that Kunth saw the sheet at Halle, I designate the Berlin specimen as the lectotype, therefore making Schlechtendal's material at Halle an isolectotype.

Kunth's original description cites another specimen, *Berlandier* 948. There is such a specimen in the Berlin herbarium but it is not annotated by Kunth so perhaps he did not see this particular sheet. This collection is a

specimen of *Tripogandra purpurascens*. These two species are similar and, as the Berlandier specimens are widely distributed, the name *T. disgrega* has been applied consistently to two different species. As Kunth drew his description from the Schiede specimen, no name other than *T. disgrega* can be applied to this species. There seems to be no other course if one believes there are two species but to call this one *T. disgrega* and to apply another name to the species represented by *Berlandier* 948.

Tripogandra disgrega has some variable morphological characteristics but I am unable to see any trends or pattern in the variation. The species is rare and has not been collected often. The vesture of the leaves varies considerably but not in any consistent way. The leaves may be glabrous on both sides or may have a varying amount of hair ranging from scattered to pilose. When hairs are found on the leaves they are also present on the internodes and on the leaf sheaths. *Tripogandra disgrega* forma *pubescens* represents the extreme condition in pilosity.

There does seem to be some correlation between the presence of hairs on the leaves and a narrowing at the base of the blade producing a subpetiolate appearance. More of the pilose-leaved plants have a narrowed blade than do the glabrous-leaved plants, but the significance, if any, of this correlation is not evident.

Tripogandra disgrega and *T. purpurascens* are very similar in most respects and on this basis I would consider them very closely related. One difference separates all specimens and a second difference separates most. *Tripogandra disgrega* has long hairs on the sepals, the longest from 1.5-4.5 mm long, while the hairs on the sepals of *T. purpurascens* are shorter and vary from 0.2-1.0 mm long on dried specimens. Most plants of *T. disgrega* have a glabrous peduncle, but in three of 31 collections there were scattered capitate hairs on the distal end. *Tripogandra purpurascens* is more variable, plants may have glabrous peduncles or any single plant may have both

glabrous and variously vestite peduncles, ranging from scattered hairs to pilose and/or with one or two lines of hairs.

The following differences between these species generally hold but there are exceptions which may be due partly to environmental influences, may be due also to genetic effects, or could be the result of undetected hybridization. *Tripogandra disgrega* usually has flat open leaves which may be subpetiolate, the plants grow in shady habitats, the petals are acuminate distally, the dorsal surface of the seeds is rounded or convex, the seeds are often obscurely ribbed, and in any given location the peak of flowering seems to occur later in each season than the peak of flowering for *T. purpurascens*. In contrast, *T. purpurascens* has complicate (folded or canaliculate) leaves which are usually rounded at the base and never narrowed and petiolate, the plants grow in open sunny locations, the petals are irregularly indented or acuminate at the apex, the seeds are prominently ribbed and the dorsal surface is flat or even concave with a deeply impressed embryotega, and flowering seems to occur earlier in each season in a given location than the peak of flowering for *T. disgrega*.

6. **Tripogandra diuretica** (Martius) Handlos, *comb. nov.*

Tradescantia diuretica Martius in Spix & Martius, Reise in Brasilien 281. 1823. HOLOTYPE: **Brazil.** Min. Ge. et S. Pauli, *Martius* (M!).

Tradescantia commelina Vellozo, Florae Fluminensis 140; 3:154. 1829 (1825). HOLOTYPE: apparently lost.

Tradescantia diuretica β foliis vaginisque magis glabris Schultes in Schultes & Schultes, Systema Vegetabilium 7:1163. 1830. HOLOTYPE: **Brazil.** *Martius* (M!).

Tradescantia gaudichaudiana Kunth, Enumeratio Plantarum 4:93. 1843. HOLOTYPE: **Brazil.** Rio Janeiro, 1832, *Gaudichaud* 125 (B!).

Tradescantia mollis Kunth, Enumeratio Plantarum 4:95. 1843. TYPE: **Brazil.** 1836, *Sello* 565 (Holotype, B!; isotype, B!).

Tradescantia selloviana Kunth, Enumeratio Plantarum 4:93. 1843. TYPE: **Brazil.** Vittoria-Bahia, 1836, *Sello* 1006 (Holotype, B!; isotype, B!).

Tradescantia diuretica α *mollis* (Kunth) Seubert in Martius, Flora Brasiliensis 3(1):251. 1855.

Tradescantia diuretica β *glabriuscula* Schultes ex Seubert in Martius, Flora Brasiliensis 3(1):251. 1855. HOLOTYPE: **Brazil.** Yrino, *Sello* 1309 (B!).

Tradescantia elongata β *diuretica* (Martius) Clarke in DC., Monographiae Phanerogamarum 3:303. 1881.

Descantaria diuretica Schlechtendal fide Hasskarl ex Clarke in DC., Monographiae Phanerogamarum 3: 304. 1881, *nom. nud. pro syn.*

Tripogandra elongata forma *diuretica* (Martius) Standley & Steyermark, Fieldiana: Bot. 24(3):38. 1952.

Illustrations: Bacigalupo, Darwiniana 14:407, 410. 1967; Figs. 4, 5k, l, as *Tripogandra elongata.*

Plants perennial, the base decumbent, rooting at the nodes; stems to 11.5 dm long, flowering stems erect, rarely branched; internodes to 12.1 cm long, with a complete or partial line of uniseriate hairs extending down the side from the sheath above, otherwise glabrous or rarely completely pilose or pilose distally. Leaves narrowly ovate to ovate; blades to 14.2 cm long, to 2.6 cm wide, base oblique, rounded on one side, cuneate on the other, dorsal and ventral side glabrous to pilose, midvein with or without a partial or complete line of uniseriate hairs ventrally, margin ciliate; sheaths to 20.0 mm long, to 9.5 mm in diam., villous at the orifice, with a line of uniseriate hairs extending down the side opposite the blade, otherwise glabrous to pilose. Inflorescences of 1-10 double cincinni borne terminally and in the upper 1-4 leaf axils; peduncles to 8.9 cm long, usually glabrous, rarely pilose or with a

few scattered uniseriate hairs; buds, flowers and/or fruits to 17 per double cincinnus; pedicels 3.5-9.0 mm long, glabrous, reflexed in fruit; bracts at the base of each pedicel glabrous or rarely pilose or with a few scattered uniseriate hairs, margin entire, with a few uniseriate hairs, or ciliate. Flowers pink; sepals narrowly ovate to ovate, cymbiform, 4.5-7.0 mm long, 1.4-3.3 mm wide, glabrous or with a few uniseriate hairs at the apex, rarely pilose, margin hyaline, apex acute; petals more or less elliptic, to 10.0 mm long, to 6.5 mm wide, base cuneate, apex acute to rounded; stamens 3, opposite the sepals, filaments 1.2-2.3 mm long, glabrous or with a few (2-3) hairs, anthers 1.0-1.8 mm long, 0.6-1.1 mm wide, basifixed, anther sacs more or less parallel; staminodes 3, opposite the petals, 4.0-6.3 mm long, bearded in the upper third or fourth with moniliform hairs, distal end bent in an S-shape, anthers 0.7-1.4 mm long, 0.8-1.5 mm wide, basifixed, with parallel, yellow anther sacs, pollen sterile; ovary 0.7-1.4 mm long, 0.7-1.0 mm in diam., glabrous, style 0.6-1.1 mm long, stigma simple. Capsule globose or obovoid, 2.8-3.5 mm long, 2.1-3.0 mm in diam., glabrous, brown; seeds 1-2 per locule, triangular, the dorsal side convex, 1.2-1.8 mm long, light gray, testa ribbed, areolate-foveate (Fig. 40), hilum elliptic or punctiform (Fig. 41).

Chromosome number: $2n=64$ (A. Sparrow, pers. comm.).

Vernacular name: trepueraval, jupirava tupice fide Martius; trepoerava fide Peckolt, Brazil.

Distribution and habitat: southern Brazil, Bolivia, Paraguay, Argentina, and Uruguay; commonly in low wet places near sea level to 1600 (-2200) m. This species in Brazil seems adapted to moist swampy locations and is not found in limestone outcrop areas as are many of the species in México (Father Reitz, verb. comm.).

Flowering: Flowering occurs from December to July.

REPRESENTATIVE SPECIMENS

Bolivia. LA PAZ: San Bartolomé, near Calisaya, Basin of Río Bopi, province of S. Yungas, 750-900 m., 1-22 July 1939, *Krukoff* 10545

(GH, K). COCHABAMBA: vic. Cochabamba, 1891, *Bang* 1282 (BM, E, F, G, GH, NY, US). **Paraguay.** Mbuveva, Apr. 1931, *Jorgensen* 4355 (US). **Brazil.** PERNAMBUCO: Pesqueira, 20 Jan. 1943, *Vellozo* 561 (R). MATTO GROSSO: *Smith* 818 (R). MINAS GERAIS: Viçosa, road from Canella to Represa, Buraco Canella, 730 m., 7 Jan. 1930, *Mexia* 5487 (BH, BM, F, GH, LA, MICH, MO, NY, PH, UC, US). RIO DE JANEIRO: Theresopolis, na Serra dos Orgãos, Jan. 1955, *Vidal* V-120 (R). FEDERAL DISTRICT: Botanical Garden and vicinity, Nov. 1915, *Curran* 7 (US). SAO PAULO: Parque do Estado de São Paulo, 26 Mar. 1931, *Hoehne* 27392 (B, NY, SP). PARANA: Jaguariahyva, 28 Mar. 1916, *Dusén* 18037 (F, MO, NY, US). SANTA CATARINA: Mina Velha, Garuva, S. Francisco do Sul, 10 m., 26 Mar. 1958, *Reitz & Klein* 6618 (NY, UC, US). RIO GRANDE DO SUL: Torres, Municipio de Torres, Feb. 1939, *Vidal* (R). **Uruguay.** MONTEVIDEO: Miguelete, 10-20 m., May 1925, *Herter* 149 (B, BH, F, GH, M, MICH, MO, MSC, NY, U, UC, WIS). **Argentina.** MISSIONES: Dep. San Pedro, Loc. Avellaneda, 8 Apr. 1949, *Schwindt* 1535 (BR, NY, US). BUENOS AIRES: Partido de Delta, Parayá Mini, 18 May 1950, *Cabrera* 10635 (US).

The plants which I have included in *Tripogandra diuretica* generally have been considered a form of *T. elongata* by taxonomists. The differences in the seeds, flowers, ratio of style length to ovary length, leaf vesture when present, and habitat are of a greater magnitude than those which serve to distinguish forms. Furthermore, I consider *T. elongata* sensu stricto to be composed of sterile material which I include in *T. serrulata*. The problem is further discussed under that species.

Variation in leaf vesture is seen among the collections of *Tripogandra diuretica*, but does not seem to follow any discernible geographic pattern.

Herbarium material of this species is unusual because a high percentage of specimens possesses open, dried flowers. This is related to the fact that flowers on plants growing in the greenhouse remain open all day and are longer lived than those of other species.

7. **Tripogandra encolea** (Diels) Macbride, Revista Univ. (Cuzco) 33(87):142. 1944.

Tradescantia encolea Diels in Urban, Bot. Jahr. Syst. 37:381. 1906. TYPE: **Perú.** CAJAMARCA: San Pablo,

2200-2400 m., 1906, *Weberbauer* 3855 (Holotype, B!; isotype, G!).

Descantaria encolea (Diels) Brückner, Notizbl. Bot. Gart. Berlin-Dahlem 10:56. 1927.

"*Tripogandra encolea* (Diels) Rohweder", Abh. Auslandsk., Reihe C, Naturwiss. 18:156. 1956.

Plants trailing, decumbent, stems branching and rooting at the nodes; flowering stems upright, to 65 cm tall, 0.1-0.4 cm in diam. when dry, green; internodes 1.5-9.5 cm long, always with a line of uniseriate hairs extending in a line laterally down the internode from the sheath above, otherwise glabrous basally and pilose distally in the erect part of the plant. Leaves narrowly ovate; blade 1.9-7.4 cm long, 0.9-2.6 cm wide, reduced to sheathing bracts near the top of the flowering stem, tapering or cordate at the base on the lower part of the stem, usually amplexicaul at the base below the inflorescence, glabrous ventrally, glabrous dorsally or sometimes pilose near the sheath, hairs uniseriate, margin ciliate, apex acute; sheaths 0.4-2.9 cm long, 0.25-0.9 cm in diam. when dry, villous at the orifice, otherwise glabrous except for a line of uniseriate hairs laterally opposite the leaf blade; sheathing bracts glabrous, pilose, or with scattered capitate hairs. Inflorescences composed of 1-4 double cincinni borne terminally and in the axils of the upper leaves; peduncles 1.0-7.0 cm long, ca. 1 mm in diam. when dried, glabrous or pilose at the base, densely pilose near the apex, hairs capitate, brown or colorless; double cincinni with 7-18 buds, flowers and/or fruits; pedicels of flowers near anthesis 0.3-0.7 cm long, pilose with capitate hairs; bracts at the base of each pedicel glabrous or pilose with capitate hairs. Flowers white or pink; sepals ovate-cymbiform, 4.5-6.2 mm long, 1.5-3.0 mm wide, pilose with brown or colorless capitate hairs, apex obtuse, margin entire; petals obovate, ca. 4-5.8 mm long, ca. 2.5-4.5 mm wide, tapering at the base, apex obtuse; stamens of outer whorl 3, shorter, filaments before anthesis 1.3-2.0 mm long, glabrous, anthers 0.9-1.5 mm long, 0.7-

1.0 mm wide, white, dorsifixed, versatile, with parallel anther sacs; stamens of inner whorl longer, filaments 3.0-3.5 mm long, densely bearded with moniliform hairs in the distal portion, anthers 0.8-1.0 mm long, 0.7-1.1 mm wide, basifixed, versatile, with yellow anther sacs parallel or diverging slightly, longer than the connective; ovary 0.9-2.0 mm long, 0.8-1.2 mm in diam., glabrous, style 0.3-0.7 mm long, stigma simple or capitellate. Capsule brown, glabrous, ca. 3 mm long, 2.5 mm in diam.; seeds 6, triangular, 1.3-1.5 mm long, dark brown; hilum punctiform to elliptical.

Distribution and habitat: Perú to Bolivia; in moist rocky soil.

SPECIMENS EXAMINED

Perú. CAJAMARCA: San Pablo, 2200-2400 m., 1906, *Weberbauer* 3855 (B, G). LA LIBERTAD: Sammne-Casmiche, Prov. Otuzco, 1800 m., 21 May 1952, *López M.* 0844 (US). LIMA: San Mateo, Prov. Huarochiri, 3200 m., 24 Mar. 1952, *Hutchison* 815 [grown and collected Univ. of Calif.-Berkeley, 19 Oct. 1957, G.B. Newcomb] (BH, F, G, GH, UC). Matucana, ca. 8000 ft., 12 April-3 May 1922, *Macbride & Featherstone* 350 (G, US); Prov. Cajabomba, Banos de Churin, 9000 ft., 7 Feb. 1946, *Laudemer* 5414 (K). **Bolivia.** COCHABAMBA: Ayopaya, Sailapata, 2700 m., *Cárdenas* 3029a (US). Río de Guinllabamba, 10 June 1876, *Andre* 3608 (K, NY).

Diels' original description of this species reported the length of leaf sheaths to be 3-4 cm, the peduncles to be 1.5-2 cm, and petals to be 8-9 mm. My measurements of the type specimens show leaf sheaths 0.7-2.9 cm long, peduncles 1.0-4.5 cm long, and petals 5.8 mm. If additional information was available to Diels he does not mention that fact.

An examination of all the specimens available of this rather rare species reveals that there are minor morphological differences among them which is not surprising if one considers the limited amount of material available and the ecological diversity of the mountains which this species inhabits.

8. **Tripogandra glandulosa** (Seubert) Rohweder, Abh. Auslandsk., Reihe C, Naturwiss. 18:156. 1956.
Tradescantia glandulosa Seubert in Martius, Flora Brasiliensis 3(1):253. 1855. HOLOTYPE: **Brazil.** PARANA: Río Negro, 7 Mar. 1823, *Sello* 995 (B!).
Tradescantia radiata Clarke in Chodat & Hassler, Bull. Herb. Boissier 3:245. 1903. HOLOTYPE: **Paraguay.** AMAMBAY: in regione cursus superioris fluminis Apa, Feb. 1901-2, *Hassler* 8493 (G!).
Tradescantia pflanzii Brückner, Bot. Jahr. Syst. 61(1): 13. 1927 ('1926'), *nom. nud.*
Descantaria glandulosa (Seubert) Brückner, Notizbl. Bot. Gart. Berlin-Dahlem 10:56. 1927.
Descantaria pflanzii Brückner, Notizbl. Bot. Gart. Berlin-Dahlem 10:57. 1927. HOLOTYPE: cult. in hort. Berol. (B!).
Descantaria radiata (Clarke) Brückner, Notizbl. Bot. Gart. Berlin-Dahlem 10:56. 1927.
Tripogandra pflanzii (Brückner) Rohweder, Abh. Auslandsk., Reihe C, Naturwiss. 18:156. 1956.
Tripogandra radiata (Clarke) Bacigalupo, Darwiniana 13:90. 1964.

Illustrations: Bacigalupo, Darwiniana 13:92, 93. 1964 (Figs. 1, 2); 14:404, 410. 1967 (Figs. 3, 5).

Plants perennial, rooting at nodes of decumbent stems; flowering stems upright, to 39 cm tall, branching from decumbent stems; internodes to 9.5 cm long, glabrous or with a partial line of uniseriate hairs extending down the stem from the sheath above. Leaves narrowly ovate to ovate; blades to 6.7 cm long, to 2.3 cm wide, glabrous, base cuneate on the lower part of the plant, rounded on the upper portion of the plant, margin ciliate, apex acute; sheaths to 11.0 mm long, to 8.6 mm in diam., a few long hairs at the orifice, a line of uniseriate hairs extending down the side of the sheath opposite the blade, otherwise glabrous. Inflorescences of 1-10 (-23) double cincinni borne terminally and in 1-4 of the upper leaf axils; peduncles

to 3.1 cm long, variously glabrous or with 1-2 lines of uniseriate hairs, or glabrous proximally and pilose distally, hairs capitate; double cincinni with up to 11 buds, flowers and/or fruits; pedicels 2.3-6.0 mm long, recurved in fruit, pilose with capitate hairs; bracts subtending each pedicel glabrous to pilose with capitate hairs, margin denticulate, entire, or ciliate. Flowers white or pink; sepals narrowly ovate, 3.0-4.2 mm long, 1.2-1.9 mm wide, pilose, hairs capitate, margin hyaline, apex acute; petals ca. 3.5-5.0 mm long; stamens 6, in two whorls, the outer shorter, filaments to 1.5 mm long, with moniliform hairs borne on the middorsal portion, anthers 0.6-0.9 mm long, 0.4-0.8 mm wide, basifixed, anther sacs parallel; stamens of the inner whorl longer, filaments to 3.3 mm long, glabrous, ligulate, concave in the upper third of their length, anthers 0.4-1.1 mm long, 0.4-0.7 mm wide, basifixed, anther sacs parallel; ovary 0.5-1.0 mm long, 0.4-0.9 mm in diam., glabrous, style 0.2-0.5 mm long, stigma simple or capitellate. Capsule globose, to 2.7 mm long, to 3.1 mm in diam., glabrous, light brown; seeds 2 per locule, rounded-triangular, 0.8-1.4 mm long, light gray to brown, testa reticulate-foveate with small prominent ribs radiating from the punctiform hilum (Figs. 42, 43).

Chromosome number: $n=8$.

Distribution and habitat: southern Bolivia and Brazil, Paraguay, Uruguay, and northeastern Argentina; in moist places and along streams.

Flowering: Flowering of this species seems to occur between September and March.

REPRESENTATIVE SPECIMENS

Brazil. PARANA: Sete Quedas, Mun. Guaira, 11 Dec. 1965, *Hatschbach, Lindeman & Haas* 13339 (US). **Paraguay.** AMAMBAY: zwischen Río Apa und Río Aquidaban, 1908-9, *Fiebrig* 4487 (BM, G, K, L). SAN PEDRO: Alto Paraguay, Primavera, 13 Oct. 1955, *Woolston* 596 (C, NY). GUARIA: Villarrica, Cerro Peladu(?), Dec. 1930, *Jorgensen* 4112 (DS, F, MO, NY, PH, US). **Argentina.** FORMOSA: Colonia Clorinda, 150 m., 30 Dec. 1926, *Venturi* 9163 (US). CATAMARCA: road 38 from Tucumán to Catamarca, Cuesta de Totoral, km. 1384.7, Dept. Paclín, 900 m., 24 Mar. 1966, *Hawkes, Hjerting & Rahn* 3989 (C). TUCUMAN:

El Duraguito, Dept. Capital, 550 m., 14 Jan. 1922, *Venturi* 1672 (F p.p., US, US p.p.). CHACO: Margarita Belén, Dept. Resistencía, 9 Dec. 1945, *Aguilar* 563 (G). SANTA FE: Lonteri, Estancia Bomazzola, 1 Feb. 1936, *Job* 1185 (US). CORRIENTES: Corrientes, 4 Sept. 1959, *Mattson* 3119 [grown in Copenhagen, collected by Pedersen in 1953] (C). ENTRE RIOS: Concepción del Uruguay, 3 Dec. 1877, *Lorentz* (GH). **Uruguay.** RIVERA: Cunapiru, 6-700 ft., 1928, *Wright* (BM). CERRO LARGO: Río Branco, 5-10 m., 27-29 Nov. 1947, *Herter* 2127 (MO, NY, US). TREINTA Y TRES: Vergara, 20 m., Dec. 1932, *Herter* 1608 (US).

Tripogandra glandulosa has very distinctive seeds and this fact was recognized by the authors of the names *Tradescantia glandulosa*, *T. radiata*, *Descantaria pflanzii*. While the seeds are diagnostic, other statements in all of the original descriptions are somewhat misleading. An examination of the type specimens shows all the floral and seed characters to be identical.

The combination *Tripogandra pflanzii* has been published three times. The Gray Herbarium Card Index credits Celarier (1955) with the earliest combination. This combination was not validly published according to Article 33 of the International Code of Botanical Nomenclature (1966). Burkart also combined the epithet in 1959, but this publication was later than Rohweder's (1956) valid publication of the name.

Bacigalupo (1964) was the first person to consider *Tripogandra radiata* and *T. pflanzii* the same species but he does not seem to have seen the type specimen of *T. glandulosa* and recognized its identity.

Several collections of apparently sterile plants have been made in Trinidad [*Broadway* 9145 (BM, UC); *Fendler* 862 (BM, K); *Grisebach* 22 (K)], French Guiana [*Sag.* 948 (BM)], and Pará, Brazil [*Huber* 93 (BM)]. Pollen from an herbarium specimen mounted in aniline blue-lactophenol did not stain and is interpreted as having been sterile and non-functional when fresh. No specimens have seeds though inflorescences are present.

These plants differ in the generally larger leaves (to 7.5 cm long), the presence of one to several lines of hairs on

the sheath, a line of hairs along the midrib on the lower leaf surface, peduncles to 4.4 cm long, and all staminal filaments glabrous. Broadway's collections have small stolon-like branches perforating the leaf sheaths.

The plants have been included in *Tripogandra glandulosa* because the morphological similarities are greater than with any other species. This decision is made reluctantly because it violates the morphological and geographic unity of the main body of collections. These plants seem to represent disjunct outliers of the main group of populations of *T. glandulosa* and with the apparent sterility, warrant further collection and study.

9. **Tripogandra grandiflora** (Donnell-Smith) Woodson, Ann. Missouri Bot. Gard. 29:153. 1942.

Callisia grandiflora Donnell-Smith, Bot. Gaz. 31:125. 1901. TYPE: **Guatemala.** ALTA VERAPAZ: Cubilguitz, 350 m., Apr. 1901, *von Tuerckheim* 7684 (Lectotype, US!; isolectotypes, GH!, MO!, US!).

Donnellia grandiflora (Donnell-Smith) Clarke in Donnell-Smith, Bot. Gaz. 33:261. 1902.

Neodonnellia grandiflora (Donnell-Smith) Rose, Proc. Biol. Soc. Wash. 19:96. 1906.

Illustrations: Donnell-Smith, Bot. Gaz. 33: Pl. XI. 1902: Moore, Jr., Baileya 8:78-80, Figs. 24, 26. 1960.

Plant perennial; stem first erect and later trailing over shrubs, to 3 m tall, to 1.0 cm in diam., unbranched or branched; internodes to 17 cm long, green, glabrous or with a complete or partial line of uniseriate hairs extending down the internode from the sheath above. Leaves two-ranked, narrowly ovate or elliptic, smaller apically and reduced to sheaths in the inflorescence; blades to 15.2 cm long, 4.4 cm wide, oblique at the base, cuneate on one side and rounded on the other, glabrous dorsally, ventral surface glabrous except for the midrib which is wholly or partially covered with uniseriate hairs, margin ciliate or entire with a few hairs near the sheath, apex acute; sheaths

of vegetative leaves to 16 mm long, 8.0 mm in diam. when dry, villous at the orifice, otherwise glabrous except for a complete or partial line of uniserate hairs extending down the side opposite the blade, sheaths of the cataphylls to 28 mm long, to 13 mm in diam., margin entire or ciliate. Inflorescences of a single terminal double cincinnus or paniculate, sometimes flexuous, composed of as many as 9 terminal and axillary double cincinni; peduncles to 4.0 cm long, or so reduced that cincinni appear sessile, green or dark green with lighter green flecks, glabrous or with 1 or 2 lines of uniseriate hairs; double cincinni with up to 13 buds, flowers and/or fruits; pedicels to 14 mm long at anthesis, to 1.3 mm in diam., green or green with a reddish tinge, glabrous, erect in fruit; bracts at the base of each pedicel entire, glabrous or with a few marginal uniseriate hairs. Flowers white; sepals narrowly ovate or elliptic, to 8.5 mm long, to 4.0 mm wide at anthesis, green or green with a pinkish base, glabrous, margin entire and hyaline, apex acute or obtuse; petals ovate, elliptic, or obovate, to 10.5 mm long, to 8.1 mm wide, cuneate at the base, apex obtuse; stamens 3, opposite the sepals, filaments 1.0-2.5 mm long, white, glabrous (Fig. 9), anthers 0.9-1.3 mm long, 0.8-1.2 mm wide, whitish, dorsifixed, versatile, open anther sacs white with a purple line around the edge (Fig. 8), pollen white; staminodes 3, opposite the petals, slightly epipetalous, filaments to 8.0 mm long, white, with two patches of uniseriate hairs in the upper half, the higher patch on the ventral side, the lower patch on the dorsal side with a few scattered hairs below the patch, filament bent in an open S-shape (Fig. 28), anthers dorsifixed, not versatile, connective orange or yellow, C-shaped with the anther sacs divergent, or connective elongate with anther sacs parallel, pollen yellow, sterile; ovary 0.7-1.6 mm long, 0.8-1.3 mm in diam., white or with a line of pink between the carpels, glabrous, style to 1.1 mm long, stigma simple or capitate and 3-lobed. Capsule elliptic, green or brown, glabrous, to 6.5 mm long; seeds gray or white and roughened, 1 or 2 per locule, elliptic (Fig. 77)

or triangular (Fig. 76), when elliptic with two sides upturned above the protuberant embryotega, to 5.0 mm long, when triangular with two sides and one end upturned forming an angular C-shaped ridge around the embryotega, to 3.0 mm long, hilum linear (Fig. 78).

Chromosome number: $n=8$, 16.

Vernacular name: hoja de fluxion, Standley and Steyermark, Guatemala, Fieldiana: Bot. 24(3):38. 1952.

Distribution and habitat: the Yucatán peninsula, southern México, Guatemala and British Honduras; at low elevations to 800-1500 m (7000-8800 ft, *Nelson* 3236c).

Flowering: Flowering occurs in August and September in the area surrounding Tuxtla Gutierrez in México and coincides with the rainy season in this location. In the area of Yucatán flowering occurs later, January to March and April. The fragrant flowers open sometime before sunrise and remain open until noon.

REPRESENTATIVE SPECIMENS

México. CHIAPAS: km. 1026 of Hwy. 190, 24 km. west of Ocozocuautla, 620 m., 13 Aug. 1967, *Handlos* 342 (BH). CAMPECHE: Monterrey, 22 Jan. 1932, *Lundell* 1225 (DS, F, MICH, US). **British Honduras.** EL CAYO: Augustine, Mountain Pine Ridge, 1450 ft., 18 Mar. 1960, *Hunt* 399 (BM, MICH, MO, US). **Guatemala.** PETEN: Santa Cruz, 27-28 Mar. 1931, *Bartlett* 12390 (F, MICH, US). ALTA VERAPAZ: between Cobán and Finca Chimoté, near Rubeltein, 800-1500 (300-500) m., 25 Feb. 1942, *Steyermark* 44203 (F, MO). IZABAL: Río Chacón, 300 ft., 10 Feb. 1921, *Johnson* 1266 (US).

Two different morphological forms can be distinguished within *Tripogandra grandiflora*. One form, representing the typical element, is more wide-spread and is characterized by leaves with a ciliate margin, a paniculate inflorescence, often with a flexuous axis and bearing 3-9 double cincinni, staminodes with a C-shaped connective and divergent anther sacs and commonly one seed per locule. Based on information on specimen labels the flowers are very fragrant. This form is found in the eastern portions of Guatemala, British Honduras, and southeastern México, the Yucatán peninsula and Chiapas.

The other form has leaves which lack the ciliate margin, there being only a few hairs at the base of the blade near the sheath. The inflorescence is composed of one to three double cincinni, the staminodes have an elongate, straight connective and the anther sacs are parallel. There are one or two seeds per locule. The flowers have a weaker fragrance if *Handlos* 342 is typical. While the evidence is limited there may also be a difference in a staminodial connective color, this form being yellow while the former is yellow or orange. The sterile pollen is more elongate in the typical element and more similar to the fertile pollen in *Handlos* 342. The second form is found in a restricted area in Chiapas, México, centering around Tuxtla Gutierrez (Ocozocuautla to San Cristóbal de las Casas).

At the present time the two forms seem to be undergoing independent evolution. There may be significant interactions and relationships between the pollinators and such floral characters as form and color of staminodes, and fragrance. If the two forms evolve in such a fashion that two distinct sets of pollinators are involved in pollination these two entities could retain their identity in the future if the populations become sympatric. Geographical isolation with some slight morphological and ecological differentiation now seems to exist. With further increase in differences these forms could be recognized as species but at this point in time it seems premature to give any nomenclatural recognition to these forms.

The United States National Herbarium is the location of two specimens which are held as the type material. According to the International Code of Botanical Nomenclature, Article 7, Note 3, only one specimen can serve as the holotype of the species. I designate the sheet (US 936917) which was annotated by C. V. Morton in August, 1940, as *Neodonnellia grandiflora*, as the lectotype with the other sheet (US 936916) to serve as an isolectotype. I have chosen this particular sheet because it holds both flowering and fruiting branches.

This species is distinguished by the revolute seed margin, the farinose seed surface, the two patches of hairs on the inner filaments, the elongate shape of the cells of the staminodial hairs and the sweetly scented flowers.

Reproduction in *Tripogandra grandiflora* is probably of two sorts, sexually by seeds and vegetatively from sections of fallen stem. Old stems fracture easily and in México I have found young plants attached to pieces of stems lying on the ground; the axillary bud at the base of the internode apparently began to grow when conditions became favorable, i.e., when sufficient moisture was available. Dispersal may be aided by the fact that the plants grow on hillsides and pieces of old stem could roll very easily to a new location. In areas with abundant tropical showers, pieces of stem could be carried and spread to new locations by water rushing down ravines and gullies.

10. **Tripogandra guerrerensis** Matuda, Anales Inst. Biol. Nac. México 36:113. 1966 ('1965'). TYPE: **México.** Guerrero: Rincón de la Via, 775 m., 24 Sept. 1961, *Kruse* 461 (Holotype, MEXU; isotype, MEXU!).

Illustration: Matuda, Anales Inst. Biol. Nac. México 36:113. 1966 ('1965').

Plants annual; stems erect, to 74 cm tall, 2-4 mm in diam. when dry, unbranched or with 1-2 branches basally; internodes 1.8-9.7 cm long, green, glabrous except for a line of uniseriate hairs continuing down the internode from the sheath on the side opposite the blade. Leaves narrowly ovate; blades 2.9-10.7 cm long, 0.3-1.1 cm wide, narrowed toward the base, smaller distally and leaves reduced to sheathing bracts in the inflorescence, glabrous ventrally, pilose dorsally, margin ciliate, apex acute; sheaths 2.0-12 mm long, villous at the orifice, otherwise glabrous except for a line of uniseriate hairs which continues down the side of the sheath opposite the blade. Inflorescences paniculate, much-branched, terminal and in the axils of the upper leaves, composed of 7-30 double cin-

cinni, peduncles 7-23 mm long, 0.4-0.6 mm in diam.; green, glabrous; bracts within the inflorescence with short lamina or reduced to a sheath near the apex; buds, flowers and/or fruits 1-5 per double cincinnus; pedicels 1.4-3.5 mm long, 0.3-0.4 mm in diam., green, glabrous or with a few scattered uniseriate or capitate hairs, erect in fruit; bracts subtending the pedicels glabrous, margin entire. Flowers white; sepals ovate-cymbiform, 2.3-3.2 mm long, 1.5-2.1 mm wide, green with purple tips, glabrous or with a few scattered capitate hairs, margin entire, apex acute or obtuse; petals ovate-elliptic, 3.5-5.0 mm long, 2.3-3.5 mm wide, tapering at the base, apex obtuse; stamens 3, opposite the sepals, filaments 1.0-1.1 mm long, white, glabrous basally but bearded dorsally in the middle with a few uniseriate, colorless hairs (Fig. 11), anthers 0.6-0.7 mm long, 0.4-0.5 mm wide, white, basifixed, versatile with anther sacs parallel, longer than the gibbous connective, pollen white; staminodes 3, opposite the petals, filaments slightly epipetalous, 3.5-4.5 mm long, white, glabrous, bent in an S-shape in the upper half, expanded in the bent portion (Figs. 15, 17), anthers dorsifixed, versatile, filaments attached near one side of the yellow, discoid connective and anther sacs borne on the side opposite the filament, connective 0.6-0.8 mm long, 0.5-0.7 mm wide, pollen yellow, sterile; ovary 0.6-0.8 mm long, 0.6-0.8 mm in diam., light green, glabrous, style 0.2-0.3 mm long, stigma simple, papillate. Capsule obovoid, glabrous, light brown, 2.9-3.6 mm long, 2.2-2.5 mm in diam.; seeds 2 per locule (Fig. 49), the upper in each locule longer (Figs. 70, 71), 1.6-1.9 mm, the lower shorter, 1.1-1.4 mm (Figs. 68, 69), triangular to elliptical, dark brown to black, testa areolate with ribs radiating from the embryotega, hilum linear-elliptical (Figs. 69, 71).

Chromosome number: $n=8$.

Distribution and habitat: México in the states of Jalisco and Guerrero; in rocky areas at low elevations. This species is known from two locations which are about 455 km apart. The intervening area is not easily accessible but it seems highly probable that there are other suitable habitats be-

tween the two known locations, and as the area is explored new collections will almost certainly be made.

Flowering: Flowering occurs in September and October in the two locations where this species has been collected. Flowers in México and in the greenhouse at Ithaca, N.Y., open about 11:00 AM and close about 2:30 PM.

SPECIMENS EXAMINED

México. JALISCO: just before km. 148 on Hwy. 110 to Colima, 5.6 km. south of bridge over Río San Pedro, ca. 1050 m., 2 Oct. 1967, *Handlos* 438 (BH); km. 147-148 on road between Colima and Mazamitla, 1040 m., 10 Sept. 1961, *Moore, Jr. & Bunting* 8746 (BH, UC).

Tripogandra guerrerensis is unique among the species I have seen in México because the petals are not symmetrically disposed at anthesis; rather, two petals bend upward so that an angle of approximately 90° is formed between the middle upright petal and the two lateral ones, whereas in all the other species the angle between petals is about 120°.

The androecium bears a constant relationship to the petals. In typical *Tripogandra*-fashion, the filaments of two of the staminodes bend around two staminal filaments and the three staminodes are then positioned in front of the middle upright petal. The stamens surround the ovary but because of the position of the petals and staminodes the anthers can not be approached by a pollinator alighting on the petals. From observations made of a natural population in Jalisco, México, on October 2 and 3, 1967, the disposition of the petals seems significant because bees are restricted in their movements and are able to gather pollen only by clinging to the staminodes. If the pollinator collects sterile pollen, it hangs from the filaments of the sterile stamens, with its abdomen pointed toward the center of the flower. While gathering sterile pollen, the abdomen is placed on the fertile anthers so that pollen is deposited on the pollinator's abdomen. This seems to be a device for insuring pollination. Insects are also able to collect fertile pollen by clinging upside down to the

staminodes with the head near the anthers. Further critical studies are needed to determine how much cross-pollination and how much self-pollination is effected. In the greenhouse, abundant viable seed was set after insects ceased entering from outdoors, so the plants are not self-sterile.

11. **Tripogandra kruseana** Matuda, Anales Inst. Biol. Nac. México 37:77, 78. 1967 ('1966'). HOLOTYPE: **México.** GUERRERO: Rincón de la Via, 735 m., 16 Oct. 1965, *Kruse* 903 (MEXU!).

Illustration: E. Matuda, Anales Inst. Biol. Nac. México 37:77. 1967 ('1966').

Plants perennial?, rooting at the nodes; flowering stems erect, to 61 cm tall, branched at the base; internodes to 9.5 cm long, with a partial line of uniseriate hairs extending down the side from the sheath above, otherwise glabrous in the lower portion of the plant. Leaves narrowly ovate; blades to 10.1 cm long, to 1.2 cm wide, glabrous, margin ciliate, apex long acuminate; sheaths to 12 mm long, to 1.0 cm in diam., a few long hairs at the orifice, with a line of uniseriate hairs on the side opposite the blade, otherwise glabrous. Inflorescences borne terminally and in the upper 3 leaf axils, composed of up to 9 double cincinni; peduncles to 1.3 cm long, pilose with capitate hairs; buds, flower and/or fruits 2-3 per double cincinnus; pedicels 8-12 mm long, green, erect in fruit, pilose with capitate hairs; bracts at the base of each pedicel with margin entire or denticulate. Flowers pink (white fide label); sepals ovate, 3.1 mm long, 1.6 mm wide in flowers available (2 mm long, 1.2 mm wide fide desc.), pilose with capitate hairs, margin red; petals not available; stamens 6, in two whorls, 3 shorter, 0.7 mm long, bearded with white moniliform hairs; 3 larger, 2 mm long, bearded with white moniliform hairs; ovary green, glabrous, style short, stigma capitellate. Capsule globose, 2.5 mm long, 2.5 mm in diam. (immature).

Distribution and habitat: This species is known only from the type collection at Rincón de la Via, Guerrero, México, in a rocky area at 735 m. altitude.

Flowering: The type specimen was in flower in mid-October.

Matuda's original description of *T. kruseana* describes the base of the leaf as amplexicaul but this is not readily discernible in the holotype. If the plant has amplexicaul leaves and is a perennial, it will key out to *T. encolea*. If the plant lacks amplexicaul leaves, as the photograph of the holotype seems to indicate, it will key near *T. saxicola* from which it may be distinguished by erect pedicels and pilose peduncles.

12. **Tripogandra montana** Handlos, *sp. nov.* HOLOTYPE: **México.** CHIAPAS: 3.2 miles N of junction of Hwy. 195 with road to El Bosque and Simojovel, 1770 (1690) m., 15 Aug. 1967, *Handlos* 355 (US!).

Herba perennis; *caulis* decumbens, usque ad 2.6 m longus, internodiis usque ad 12.8 cm longis, glabris vel raro distaliter pilosis, linea unica pilorum instructis. *Folia* angusto-ovata, laminis usque ad 14.5 cm longis, usque ad 3.5 cm latis, apice acutis, basi obliquis, glabris vel pilis paucis dispersis instructis vel pilosis, margine ciliatis vel medio nonnunquam eciliatis, vaginis usque ad 18.0 mm longis, usque ad 12.5 mm diam., linea unica pilorum instructis, aliter glabris vel pilis dispersis instructis vel pilosis, orificio villosis vel pilis dispersis praeditis. *Inflorescentiae* terminales et in 1-4 axillis foliorum summorum, ex 1-17 cincinnis duplicibus constantes; *pedunculi* 0.7-12.7 cm longi, glabri, pilosi vel 1-2 lineis pilorum instructi; *cincinni* duplices omnes alabastra, flores, vel fructus usque ad 17 gerentes; *pedicelli* usque ad 2.5-6.0 mm longi, 0.6-0.8 mm diam., maturitate reflexi, pilis capitatis paucis instructi vel pilosi, bracteis basi pedicellorum glabris vel pilis capitatis vel uniseriatis dispersis pubescentibus, margine ciliatis vel eciliatis. *Flores* rosei; *sepala*

anguste ovata, elliptica, vel obovata, cymbiformia, 4.0-6.0 mm longa, 1.6-2.8 mm lata, pilosa vel pilis paucis, dispersis, capitatis instructa, margine integra et hyalina, apice obtusa; *petala* ovata, 5.5-11.0 mm longa, 3.5-6.8 mm lata, basi cuneata, apice rotundata; *stamina* 6 in verticillis duobus, 3 sepalis opposita filamentibus brevibus, 1.0-2.5 mm longis, subroseis, glabris vel raro pilis paucis praeditis (Fig. 10), antheris 0.8-1.8 mm longis, 0.6-1.2 mm latis, polline albido, 3 petalis opposita filamentibus epipetalis, sigmoideis, 4.5-7.5 mm longis, medio pilis roseis moniliformibus pubescentibus (Fig. 31), antheris 0.5-0.9 mm longis, 0.5-1.1 mm latis, polline luteo; ovarium 1.2-1.7 mm longum, 0.8-1.2 mm diam., glabrum, stylo 0.2-0.6 mm longo, stigmate capitellato vel capitato. *Capsula* elliptica, 2.0-3.7 mm longa, 1.6-2.6 mm diam., glabra, seminibus triangularibus, 1.1-1.7 mm longis, reticulatis (Figs. 44-46), hilo punctiformi (Fig. 45).

Chromosome number: $n=21$.

Vernacular name: tzima fide Standley, Guatemala.

Distribution and habitat: southern México, Guatemala, Honduras, and El Salvador; in pine-oak forest areas at higher elevations, ca. 1100-2500 m. The one undisturbed location in which I found this species was in a black loam soil in a pine woods with a scattering of oaks, *Liquidambar* and tree ferns. The plants grew on a moist, east-facing slope. An adjacent, drier, sunnier and steeper west-facing slope had no plants of this species.

Flowering: In México flowering occurs between March and November; in Guatemala between November and June; in Honduras in February, March, April, July and November. The flowers open about 8:00 AM in their natural habitat and close about 2:00 PM. The plants I found had odorless flowers. Flowering seems to extend over a long period of time because both young inflorescences and mature seed were found in the location where *Handlos* 355 was collected.

REPRESENTATIVE SPECIMENS

México. CHIAPAS: in the paraje of Kulak'tik, Municipio of Tenejapa, 5500 ft., 25 Nov. 1965, *Breedlove* 14205 (DS, F, MICH). **Guatemala.** HUEHUETENANGO: Canyon of Río Chixoy near Malacatancito about 20 km. southwest of Huehuetenango, 1600 m., 1 Dec. 1962, *Williams, Molina R. & Williams* 22149 (F, NY). QUICHE: Cunen, 6000 ft., Apr. 1892, *Heyde & Lux* 3521 (GH, M, NY, US). ALTA VERAPAZ: Chicoyonito, 4300 ft., Apr. 1889, *Donnell-Smith* 1643 (GH, NY, PH, US). SAN MARCOS: slopes bordering Río Malacáte, barrancos 6 miles south and west of town of Tajumulco, northwestern slopes of Volcán Tajumulco, 2300-2800 m., 26 Feb. 1940, *Steyermark* 36679 (F). QUEZALTENANGO: mountains above Río Samalá, Sierra Madre Mountains, 2 km. west of Zunil, 2300 m., 14 Dec. 1962, *Williams, Molina R. & Williams* 23023 (F, NY). SOLOLA: steep slopes of Panajachel water falls, road to Solalá, 2200 m., 12-23 Jan. 1966, *Molina R., Burger & Wallenta* 16233 (F, NY). CHIMALTENANGO: near Río Pixcayó, between Chimaltenango and San Martín Jilotepeque, 1650-1800 m., 3 Feb. 1939, *Standley* 64362 (F). SACATEPÉQUEZ: slopes of Volcán de Agua, south of Santa María de Jesús, 1800-2100 m., 10 Dec. 1938, *Standley* 59449 (F). GUATEMALA: damp wooded barranca 10 km. south of San Raimundo, about 1800 m., 18 Jan. 1939, *Standley* 62882 (F). EL PROGRESO: Montaña Canahui, between Finca San Miguel and summit of mountain, near upper limits of Finca Caieta, 1600-2300 m., 10 Feb. 1942, *Steyermark* 43764 (F). ZACAPA: along Rillito del Volcán de Monos, Volcán de Monos, 1150-2100 m., 10 Jan. 1942, *Steyermark* 42336 (F, MO). CHIQUIMULA: Montaña Nonojá, 3-5 miles east of Camotán, 600-1800 m., 11 Nov. 1939, *Steyermark* 31687 (F). SUCHITEPÉQUEZ: southwestern lower slopes of Volcán Zunil, in vicinity of Finca Montecristo, southeast of Santa Mariá de Jesús, 1200-1300 m., 31 Jan. 1940, *Steyermark* 35221 (F). **Honduras.** COPAN: 5 km. al S.O. de Santa Rosa de Copán, 1200 m., 29 Mar. 1963, *Molina R.* 11675 (F). COMAYAGUA: vicinity of Siguatepeque, 1080-1400 m., 14-27 Feb. 1928, *Standley* 56198 (F, US). INTIBUCA: Baños de Esperanza, 1800 m., 27 Nov. 1958, *Hawkes, Hjerting & Lester* 2103 (C, F). **El Salvador.** Santo Tomás, 1922, *Calderón* 1294 (NY, US).

The collections which I have included in *Tripogandra montana* have usually been identified as *T. elongata* in the past. On the basis of a distinct seed reticulation, a capitate stigma, a short style, a different leaf texture, adaptation to a relatively moist montane habitat, and a different and distinct geographic range, I must recognize *T. montana* as different from *T. elongata*. *Tripogandra elongata* is

discussed further under *T. serrulata*. The long peduncles and bright pink flowers of *T. elongata* may indicate some affinity with *T. montana* but this is only speculation.

Variation in leaf vesture does occur within this taxon but that seems to be a common occurrence within this genus. The significance, function, and mode of inheritance of this character should be investigated further.

13. **Tripogandra multiflora** (Swartz) Rafinesque, Flora Telluriana 2:16. 1837 ('1836').

Tradescantia multiflora Swartz, Nova genera & species plantarum seu prodromus . . . Indiam occidentalum 57. 1788; Flora Indiae occidentalis 1:599. 1797; 3:1972. 1806; Jacquin, Collectanea ad botanicam . . . 3:226, 227. 1791. TYPE: **Jamaica.** *Swartz* (Holotype, (B)?; isotype, M!).

Tradescantia parviflora Ruiz & Pavon, Florae Peruvianae et Chilensis prodromus, . . . 3:43. 1794. TYPE: **Perú.** HUANUCO: Pozuzo, 1778-1788, *Ruiz & Pavon.* (Holotype, MA; photograph, MA!; isotype, F!).

Tradescantia procumbens Willdenow, Species Plantarum 2:19 1799. HOLOTYPE: *Jacquin* (B); photograph, B!.

Commelina floribunda HBK., Nova genera et species plantarum 1:260. 1816. HOLOTYPE: Cumana, Bordones & Quetepe, *Humboldt & Bonpland* (B); photograph, B!.

Heminema multiflora (Swartz) Rafinesque, Flora Telluriana 2:17. 1837 ('1836').

Aneilema floribunda (HBK) Hooker & Arnott, The Botany of Captain Beechey's Voyage 311. 1840.

Tradescantia cumanensis Kunth, Enumeratio Plantarum 4:96. 1843, based on *Commelina floribunda* HBK non *Tradescantia floribunda* M. & G. (1842) nec *T. floribunda* Kunth (1843).

Tradescantia multiflora γ *linnaei* Clarke in DC., Monographiae Phanerogamarum 3:306. 1881. TYPE:

Colombia. in montibus juxta Bogotam, 6 Nov. 1852, *Holton* 127 (Holotype, K!; isotype, NY!).

Tradescantia multiflora β *parviflora* (Ruiz & Pavon) Clarke in DC., Monographiae Phanerogamarum 3:306. 1881.

Descantaria procumbens Schlechtendal fide Hasskarl ex Clarke in DC., Monographiae Phanerogamarum 3:305. 1881, *nom. nud. pro syn.*

Leptorhoeo floribunda (HBK) Baillon, Histoire des Plantes 13:218. 1894 ('1895').

Tradescantia ionantha Diels in Urban, Bot. Jahrb. Syst. 37:382. 1906. TYPE: **Perú.** PUNO: Sandia, 2100 m., 24 Mar. 1902, *Weberbauer* 588 (Holotype, B!; isotype, G!).

Tradescantia multiflora var. *tobagensis* Urban, Symbolae Antillanae 7:174. 1912. HOLOTYPE: **Tobago.** juxta flumen "Bacolet" ad "Calder Hall", 31 Oct. 1889, *Eggers* 5693 (B!).

Descantaria multiflora (Swartz) Brückner, Notizbl. Bot. Gart. Berlin-Dahlem 10:56. 1927.

Descantaria cumanensis (Kunth) Schlechtendal ex Brückner, Notizbl. Bot. Gart. Berlin-Dahlem 10:56. 1927.

Descantaria ionantha (Diels) Brückner, Notizbl. Bot. Gart. Berlin-Dahlem 10:56. 1927.

Tripogandra floribunda (HBK) Woodson, Ann. Missouri Bot. Gard. 29:152. 1942.

Tripogandra cumanensis (Kunth) Woodson, Ann. Missouri Bot. Gard. 29:152. 1942.

Tripogandra ionantha (Diels) Macbride, Revista Univ. (Cuzco) 33(87):142. 1945.

Tripogandra parviflora (Ruiz & Pavon) Steyermark, Phytologia 9:339. 1963 ('1964').

Tripogandra multiflora (Swartz) Woodson [fide Bacigalupo] forma *parviflora* (Ruiz & Pavon) Bacigalupo, Darwiniana 14:398. 1967.

Illustrations: Jacquin, Icones Plantarum rariorum 2: 355. 1790 ('1781-1795'); Moore, Jr., Baileya 8:81, Fig. 27. 1960; Bacigalupo, Darwiniana 14:399, Fig. 1, 1967.

Plants perennial, trailing and rooting at the nodes or caespitose; floriferous stems upright, to 83 cm tall, unbranched or branched; internodes to 13.5 cm long, the uppermost 1-4 pilose (rarely glabrous), the lower glabrous or glabrous proximally and pilose distally, in all specimens with a line of uniseriate hairs extending down the stem from the sheath above. Leaves narrowly ovate, ovate or broadly ovate; blades to 8.8 cm long, to 2.8 cm wide, glabrous or pilose dorsally, the ventral surface variously glabrous, pilose and/or with a line or band of uniseriate hairs near the margin, occasionally the base of the midvein with a line of uniseriate hairs, base oblique, cuneate, or rounded, margin ciliate, apex acute; sheaths to 14.2 mm long, to 9.2 mm in diam., villous at the orifice, the uppermost 1-7 pilose (rarely glabrous), the lower ones glabrous or pilose, in all specimens with a line of uniseriate hairs extending down the side opposite the blade. Inflorescences of 1-26 double cincinni borne terminally and in the axils of the upper 1-8 leaves; peduncles to 3.5 (-5.4) cm long, densely pilose or rarely pilose distally and glabrous proximally; double cincinni with up to 16 buds, flowers and/or fruits; pedicels 1.4-4.0 mm long, reflexed in fruit, glabrous, with scattered uniseriate hairs or pilose; bracts at the base of each pedicel glabrous, with scattered uniseriate hairs, or pilose, margin entire or long-ciliate. Flowers white or pink; sepals ovate-cymbiform, 1.8-4.0 mm long, 1.0-1.8 mm wide, green, red, or green with a red tip and/or base, glabrous, with scattered capitate hairs, or pilose, margin hyaline, apex more or less acute; petals broadly ovate(?), 1.6-4.0 mm long, 1.0-ca. 2.2 mm wide; stamens 6, in two whorls, the outer shorter, filaments 0.5-1.3 mm long, glabrous, anthers 0.3-0.6 mm long, 0.3-0.6 mm wide, pink, basifixed, anther sacs parallel; stamens of the inner whorl longer, 1.4-3.2 mm long, S-shaped, bearded with a ventral

tuft of moniliform hairs below the expanded distal end, anthers 0.3-0.5 mm long, 0.2-0.8 mm wide, dorsifixed, connective I- or C-shaped, yellow, anther sacs divergent or parallel through bending of the connective; ovary 0.5-1.0 mm long, 0.4-0.8 mm in diam., glabrous, style 0.15-0.3 mm long, stigma capitellate or capitate. Capsules 1.4-2.5 mm long, 1.5-2.5 mm in diam., green or light brown, glabrous; seeds 1-2 per locule, rounded-triangular, 0.7-1.0 (-1.4) mm long, light or dark gray or brown, testa reticulate-foveate (Figs. 32, 34), hilum punctiform (Figs. 33, 35).

Chromosome number: $2n=64$ (A. Sparrow, pers. comm.)

Distribution and habitat: Jamaica, Trinidad, Tobago, Costa Rica, Venezuela, Colombia, Perú, Bolivia, and Argentina; on shaded or open rocky banks or slopes from sea level to 2900 m.

Flowering: In Jamaica flowering occurs from June to February; in Trinidad and Tobago in July and October; in Costa Rica in November; in Venezuela from August to January and in May and June; in Colombia from May to February; in Perú in March, July, November, and December; in Bolivia from December to May.

REPRESENTATIVE SPECIMENS

Jamaica. Troy, 2000 ft., 16 Oct. 1917, *Harris* 12573 (F, NY, US). MANCHESTER: vicinity of Mandeville, 15-26 Feb. 1910, *Brown* 84 (NY, PH). ST. ANDREW: off road from Kingston to Newscastle, 1250 ft., 17 June 1963, *Crosby, Hespenheide & Anderson* 178 (F, MICH, MSC, UC). **Tobago.** Roxborough, 20 July 1914, *Broadway* 4906 (US); Mason Hall, 19 Oct. 1937, *Sandwith* 1865 (NY). **Trinidad.** Point opposite Melville Island, 25 Oct. 1925, *F*[*reeman*] *& W*[*illiams*] 11408 (NY). **Costa Rica.** SAN JOSE: vicinity of El General, 1160 m., Nov. 1936, *Skutch* 2935 (GH, K, MO, NY, US). **Venezuela.** FALCON: Meachiche, 18 Jan. 1942, *Lasser* 178 (US, VEN). LARA: Loma de León Dto. Yribarren, 16 Sept. 1950, *Tamayo* 3726 (VEN). DISTRITO FEDERAL: La Quesera, Upper Cotiza, near Caracas, above 1400 m., 18 Sept. 1921, *Pittier* 9821 (US, VEN). MIRANDA: Los Mariches, on new road to Sta. Lucia, 14 Dec. 1924, *Pittier* 11636 (US, VEN). MERIDA: 3 miles west; 2 miles south of Mérida Valley, 4500 ft., 26 Jan. 1931, *Reed* 335 (US). **Colombia.** MAGDALENA: Sierra Nevada de Santa Marta, southeastern slopes; Hoya del Río Donachuí; below the vil-

lage Donachuí near the river, 1350-1230 m., 24 Sept. 1959, *Cuatrecasas & Castaneda* 24406 (US). NORTE DE SANTANDER: vicinity of Mutiscua, 2900 m., 20-22 Feb. 1927, *Killip & Smith* 19669 (US). SANTANDER: vicinity of Charta, 2000-2600 m., 1-11 Feb. 1927, *Killip & Smith* 17446 (GH, NY, US). BOYACA: Valle de la Uvita, Cordillera Oriental, 2490-2560 m., 16 Sept. 1938, *Cuatrecasas* 1857 (US). CUNDINAMARCA: Macizo de Bogotá, Quebrada de Chicó, 2650-2750 m., 1 June 1939, *Cuatrecasas* 5224 (US). HUILA: Cordillera Oriental, east of Neiva, 800-1000 m., 31 July 1917, *Rusby & Pennell* 424 (NY). **Perú.** SAN MARTIN: prope Tarapoto, 1855-6, *Spruce* 4198 (BM, BR, E, NY). HUANUCO: west and above Puente Durand, north of Huanuco, 1900 m., 4 Nov. 1938, *Stork & Horton* 9589 (G, GH, K). LIMA: Lima, 1 July 1914, *Rose & Rose* 18551 (US). CUSCO: Potrero, Convención, 1300 m., 2 Mar. 1940, *Vargas C.* 1832 (GH). PUNO: Sandia, 2100 m., 24 Mar. 1902, *Weberbauer* 588 (B, G). **Bolivia.** LA PAZ: Apolo, 4800 ft., 10 Mar. 1902, *Williams* 55 (BM, US).

Tripogandra multiflora is a widespread species in South America and a complex pattern of variation seems to exist within the species as I conceive it. Collections below about 2,000 meters from Colombia, Venezuela and the Caribbean islands form a fairly uniform group characterized by a trailing habit, glabrous leaves with an oblique base, white flowers and pilose sepals.

Collections from Bolivia in contrast are quite variable. The leaf base is usually oblique and the base of the plant seems to be decumbent. The flower color may be either white or pink, sometimes even in the same collections, e.g., *Buchtien* 399. The leaf indument is variable — the leaves may be (1) glabrous dorsally with a band of hairs near the margin ventrally as in *Williams* 55; or (2) pilose on both sides as in *Rusby* 1369, *Buchtien* 2457, 4183 (F, GH), 7190 (GH), *Bang* 603 (F, M, MICH); or (3) pilose dorsally with a ventral marginal band of hairs as in *Buchtien* s.n., 399 (US), 4183 (F), 7190 (NY), *Bang* 603 (E, F, GH, MO, PH, US). The sepals may be glabrous as in *Williams* 55, *Buchtien* s.n., 399 (US), 4183 (F), 5350, 7190 (NY), *Bang* 603 (E, F, GH, MO, NY, PH, US), or have scattered capitate hairs as in *Rusby* 1369, *Buchtien* 399 (US), 2457 (NY), 4183 (GH), 7190 (GH), *Bang* 603 (M, MICH); or be pilose as *Buchtien* 4183 (F, G). These plants must be studied in

the field for a better understanding of the problems. I do not know whether hybridization is occurring. It is possible that collections have become mixed before being glued to herbarium sheets; most collections were made by Buchtien and Bang. It is possible, however, that the species in Bolivia is very polymorphic with some obvious traits segregating within the populations.

Plants which grow in the highlands of Colombia, Perú and Bolivia, above 2,000 meters elevation, tend to be caespitose and the leaves are generally broadly ovate with a cuneate to nearly amplexicaul base. Compared to lowland plants of *T. multiflora* there are few inflorescences and these are partially covered by the upper one to five leaves; the sepals, petals and pistil tend to be longer and the stigma is broader, more nearly capitate than capitellate. The flowers are always bright pink or magenta. I can find no qualitative characters (aside, perhaps, from flower color) which will allow one to separate the plants of this group from the bulk of *T. multiflora.* The presence of plants which appear intermediate between the highland and lowland forms leads me to consider the highland plants as a mountain ecotype of *T. multiflora.* Intergradation as seen from herbarium specimens may be more apparent than real. It is possible that these forms are ecologically separated and generally do not intergrade but are very similar species. If one considers evolution to be a continuous and gradual process and not saltational, then it is possible that the situation just described represents a slight ecological divergence with no overwhelming morphological differences, a case of sibling or micro-species. These essential questions can only be settled with further field work.

Because of the pattern of morphological variations occurring within *Tripogandra multiflora*, a number of names have been applied to this species. These names are considered in detail here.

Willdenow (1799) named *Tradescantia procumbens* from a collection with a procumbent stem from mainland South

America. This name seems unnecessary for there appear to be no other characters by which the island and the mainland populations differ. Observations of greenhouse grown plants and information on herbarium labels indicate that, in fact, the island plants also tend to trail over the ground.

Ruiz and Pavon's *Tradescantia parviflora* does not seem sufficiently distinct to be recognized as a species, the only distinguishing character being the presence of pilosity on the dorsal leaf surface. Clarke (1881) considered *T. parviflora* a variety (β) of *Tradescantia multiflora*. No other collections that I have seen duplicate the distribution of hairs found on the Ruiz and Pavon specimen. The other collections cited under variety *parviflora* by Clarke have additional hairs in a line near the margin on the ventral surface which are not found in the Ruiz and Pavon specimen. Bacigalupo (1967) considered *Tradescantia parviflora* a form of *Tripogandra multiflora*. The specimen which he cites from Argentina apparently has additional indument on the ventral leaf surface not found on the Ruiz and Pavon specimen. In terms of the distribution of hairs on the leaves, the Ruiz and Pavon specimen seems, therefore, to be an intermediate between the Bolivian, Argentinian and other Peruvian collections and the Colombian, Venezuelan and Jamaican glabrous-leaved plants. Steyermark (1963) cited specimens of *Tripogandra parviflora* from Ecuador but apparently these are referable to a species of *Gibasis*.

Urban's variety *tobagensis* of *Tradescantia multiflora* is represented by a very few collections. While the seeds he observed were 0.6-0.7 mm in diameter, I find that seeds from other collections on Trinidad and Tobago range from 0.7-1.0 mm in diameter. The plants do seem smaller but a formal Latin designation seems unnecessary. The small stature of the plants may represent only stunted growth and no real genetic difference.

The mountain ecotype described earlier was named *Tradescantia multiflora* variety γ *linnaei* by Clarke (1881)

and *T. ionantha* by Diels (in Urban, 1906). Judging from herbarium specimens there seems to be no character except, perhaps, the bright magenta flower color by which these plants can be distinguished.

The names *Tradescantia cumanensis* and *Tripogandra cumanensis* have been applied to specimens of *Tripogandra serrulata,* but these usages seem to stem from an initial misidentification of specimens by Clarke. Kunth's original description of *Tradescantia cumanensis* (as *Commelina floribunda*) notes that the top of the stem and the peduncle are "hirto-pilosis" while the sepals are "glanduloso-pilosis." These characters coincide with those found in *T. multiflora* which is common in Venezuela where the type of *T. cumanensis* was collected, but these characters are not found in *T. serrulata* which seems to be rare or at least not often collected in Venezuela.

Kunth's concept of similarities may be considered as a further line of evidence to demonstrate the identity of *T. multiflora* and *T. cumanensis.* Kunth (1843) grouped similar species in his treatment of the family and he noted the affinities he believed existed. It can be seen that *Tradescantia schlechtendalii* (a synonym for *Tripogandra serrulata*) is number 41 in Kunth's list while *T. procumbens, T. parviflora, T. multiflora,* and *T. cumanensis* are numbers 44, 45, 46, and 47, respectively. Using this evidence as a reflection of similarities, *T. cumanensis* stands apart from *T. schlechtendalii* (=*Tripogandra serrulata*) but close to *T. multiflora.* I have only seen a photograph of the holotype of *T. cumanensis* but an examination of seeds of this specimen would make a positive indentification possible.

By application of the Internal Code of Botanical Nomenclature, *Aneilema floribunda, Leptorhoeo floribunda* and *Tripogandra floribunda* based on *Commelina floribunda* HBK must be cited in synonymy under *Tripogandra multiflora* for reasons which follow.

Hooker and Arnott published the combination *Aneilema floribunda* based on *Commelina floribunda* HBK but the

specimen to which they applied this name was a species of *Leptorhoeo,* a genus in need of further study. Subsequent authors, Baillon (1894) and Woodson (1942), have credited Hooker and Arnott as authors of the specific epithet, *floribunda,* but Hooker and Arnott correctly credited HBK and did not, in fact, publish a new species description though they did apply the name incorrectly.

Rohweder (1956) published *Tripogandra ionantha* and Steyermark (1964) published *T. multiflora* as new combinations. Both of these names were validly published earlier so neither Rohweder nor Steyermark can be credited as the correct authors.

14. **Tripogandra neglecta** Handlos, *sp. nov.* HOLOTYPE: **Brazil.** MINAS GERAIS: ad Lagoa Sta., 27 Mar. 1864, *Warming* 1069/1(C!).

Herba annua(?); *caulis* erectus, usque ad 40 cm altus, internodiis usque ad 10.5 cm longis, linea unica pilorum instructis aliter glabris. *Folia* angusto-ovata, laminis usque ad 11.3 cm longis, usque ad 2.1 cm latis, apice acutis, basi cuneatis, glabris, margine ciliatis, vaginis usque ad 2.3 cm longis, usque ad 1.0 cm diam., linea unica pilorum instructis, aliter glabris, orificio parce villosis. *Inflorescentiae* terminales et in axillis foliorum summorum, ex 4-9 cincinnis duplicibus constantes; *pedunculi* usque ad 4.0 cm longi, 1-2 lineis pilorum instructi, cincinni duplices omnes alabastra, flores, vel fructus usque ad 12 gerentes; *pedicelli* usque ad 5.5 mm longi, glabri, maturitate reflexi, bracteis basi pedicellorum margine integris, glabris. *Flores* albi?; *sepala* ovata, cucullata, usque ad 4.0 mm longa, usque ad 2.3 mm lata, pilis paucis uniseriatis instructa, margine integra et hyalina, apice ± obtusa; *petala* ovata, apice obtusa; *stamina* 6 in verticillis duobus, 3 sepalis opposita filamentibus brevibus, usque ad 1.3 mm longis, glabris, antheris usque ad 1.1 mm longis, usque ad 1.2 mm latis, 3 petalis opposita filamentibus longioribus, usque ad 3.2 mm longis, sigmoideis, barbatis distaliter, antheris usque ad 0.8 mm longis, usque ad 1.2 mm latis, connectivo C-

formi; *ovarium* usque ad 1.0 mm longum, usque ad 0.8 mm diam.. glabrum, stylo usque ad 0.6 mm longo, stigmate simplici. *Capsula* globosa, usque ad 3.0 mm longa, usque ad 3.1 mm diam., glabra, seminibus triangularibus, usque ad 1.6 mm longis, minute reticulatis, hilo punctiformi.

Distribution and habitat: Known only from one location in Brazil.

Flowering: The one specimen available was in flower and fruit in March.

SPECIMENS EXAMINED

Brazil. MINAS GERAIS: ad Lagoa Santa, 27 Mar. 1864, *Warming* 1069/2 (C); without precise location: *Warming* (C).

This rarely collected species is similar to *Tripogandra diuretica* from which it differs in the shape of the leaf base, the unique presence of a few uniseriate hairs at the junction between adjacent sepals, the flower color, the surface texture of the testa and duration (apparently).

15. **Tripogandra palmeri** (Rose) Woodson, Ann. Missouri Bot. Gard. 29:153. 1942.

Tradescantia palmeri Rose, Contr. U.S. Nat. Herb. 1:113. 1891. TYPE: **México.** SONORA: Alamos, 16-30 Sept. 1890, *Palmer* 737 (Holotype, US!; isotypes, GH!, NY!).

Descantaria palmeri (Rose) Brückner, Notizbl. Bot. Gart. Berlin-Dahlem 10:56. 1927.

Illustration: Matuda, Anales Inst. Biol. Nac. México 26:374. 1956 ('1955'). The magnification is given as $\times 1/2$ but it is more nearly $\times 1$.

Plants annual; stems erect, to 45 cm tall, to 4.0 mm in diam. when dry, unbranched to branched at every node (6 branches); internodes to 11.7 cm. long, green, glabrous to pilose. Leaves elliptic, narrowly ovate, or ovate; blades 0.7-9.5 cm long, 0.2-4.0 cm wide, cuneate, rounded or truncate at the base, dorsal surface glabrous or pilose, ventral surface variously glabrous, glabrous with a few uniseriate hairs along the base of the midvein, or pilose, margin

ciliate, apex acute; sheaths 1.0-9.5 mm long, 0.6-9.5 mm in diam. when dry, villous at the orifice, with a line of hairs extending down the side opposite the blade, otherwise glabrous or pilose. Inflorescences borne terminally and in the axils of the upper leaves; peduncles to 5.4 cm long, or so reduced that cincinni appear sessile, green, proximally glabrous or pilose, hairs uniseriate, distally variously glabrous, with a few scattered hairs, or pilose, hairs capitate; cincinni with 2-21 buds, flowers and/or fruits; pedicels 1.5-8.0 mm long at anthesis, 0.3-0.6 mm in diam., green, variously glabrous, with a few scattered capitate hairs, or pilose, erect at anthesis and in fruit; bracts at the base of the pedicels with an entire margin, glabrous or with a few scattered capitate hairs. Flowers white; sepals cymbiform, elliptic to ovate, 1.5-4.1 mm long, 1.0-2.3 mm wide, green with the tip darker, pilose or with a few scattered capitate hairs, margin entire and hyaline, apex acute or obtuse; petals elliptic, ovate, or obovate, 2.0-4.5 mm long, ca. 1.0-5.0 mm wide, cuneate at the base, apex obtuse or rounded; stamens 3, opposite the sepals, shorter than the staminodes, filaments 0.5-1.2 mm long, colorless with a few (1-6) uniseriate hairs on the upper half of the dorsal side (Fig. 13), anthers 0.3-1.0 mm long, 0.2-0.6 mm wide, white, basifixed, with white anther sacs, pollen white; staminodes 3, opposite the petals, longer, slightly epipetalous, filaments 1.5-3.4 mm long, white, glabrous, slightly bent in the middle (Fig. 21) or S-shaped above the middle (Fig. 22), anthers 0.3-1.0 mm long, 0.4-0.9 mm wide, broadly basifixed, not versatile, connective yellow, inconspicuous, broadened with anther sacs parallel, or C-shaped with the anther sacs divergent, pollen white or yellow; ovary 0.5-1.0 mm long, 0.4-0.9 mm in diam., white, glabrous, style 0.2-0.4 mm long, stigma simple. Capsule globose, 2.0-3.3 mm long, brown or green, glabrous; seeds one per locule, ovate with the broad end and two sides rolled inward (involute) which results in concavities on three sides due to the inrolling, these concavities alternating with three convexities where the edge is not rolled

(turned), involute margins nearly touching and covering the protruding embryotega (Fig. 72), testa black, areolate, hilum linear (Fig. 73).

Chromosome number: $n=16$.

Distribution and habitat: México, in the states of Sonora, Sinaloa, Jalisco, Michoacán, Guerrero, and Puebla; at low elevations, 50 to ca. 1400 m. The plants grow in relatively dry areas with seasonal rainfall; the vegetation is characterized as thorn scrub; candelabra cacti usually are abundant. The soil in which these plants grow is brown or black loam with abundant humus but in dry stream beds it is loose due to the presence of sand and gravel.

Flowering: Plants flower in August, September and October. The flowers commonly open about 8:00 AM and close about noon.

REPRESENTATIVE SPECIMENS

México. SONORA: Chorijoa, Río Mayo, 22 Aug. 1935, *Gentry* 1598 (ARIZ, F). SINALOA: El monte, Los Labrados, 50 m., 15 Oct. 1926, *Mexia* 927 (UC, US). JALISCO: near Bolaños, Sept. 1897, *Rose* 2891 (GH, K, NY, US). MICHOACAN: Apatzingán, Dist. Apatzingán, 300 m., 19 Aug. 1938, *Hinton et al.* 12051 (GH, K, NY). MEXICO: Cerro de Los Capulines, Palmar Chico, 1100 m., 26 Aug. 1954, *Matuda* 31337 (MEXU). GUERRERO: Coyuca-Chacamerito, Dist. Coyuca, 19 Sept. 1934, *Hinton et al.* 6620 (GH, K, MICH, NY, US). PUEBLA: km. 232.5 of Hwy. 190, ca. 4 km. west of Río Atoyac, 1370 (1040)m., 9 Sept. 1967, *Handlos* 403 (BH).

Tripogandra palmeri is unique because the seeds are borne one per locule; at anthesis there are two ovules in each locule but the lower one always aborts. The seeds are further unique in that the margins are involute on three sides, rolling up in such a fashion that they nearly cover the protuberant embryotega.

An interesting pattern of morphological variation can be seen in the 20 collections I have examined. All 15 collections made north of Guerrero or north of 18° 30′ N latitude have narrowly ovate, nearly glabrous leaves, few flowers per inflorescence, a narrow connective, parallel

anther sacs and epipetalous filaments which are bent slightly in the middle. The five collections made south of 18° 30′ N in the southern drainage area of the Río Balsas-Río Mexcala have larger, more nearly ovate leaves which are commonly pilose on both surfaces (though some plants have leaves which are glabrous ventrally except for the midvein), there are more flowers per inflorescence, the connective is C-shaped, anther sacs are divergent, and the epipetalous filaments are S-shaped. Both of these forms were collected in the drainage basin of the Río Balsas. As the plants are annuals and self-pollination is probably the most common breeding pattern, variation in local populations would be expected to be small. Since the two morphological types occur in different geographical areas they might be recognized as subspecies. Because so few collections have been made. a more complex pattern of variation may emerge in the future and I decline, therefore, to introduce a new name. However, the linear distance covered by this limited number of collections is rather extensive, 1140 and 360 kilometers for the northern and southern forms respectively. Further studies and collections should be made throughout the range of this species and especially in the Guerrero-Michoacán border area in the region of Presa del Infiernillo and to the east which is the area of presumed contact between the two forms.

16. **Tripogandra purpurascens** (Schauer) Handlos, Baileya 17:33. 1970.

Tradescantia purpurascens Schauer in Nees ab Esenbeck and Schauer, Linnaea 19:700. 1847. HOLOTYPE: Mejico, *Aschenborn* 493 (B!).

Plants annual; stem erect, to 73 cm tall, branched or unbranched, lower portion sometimes decumbent, then rooting at the nodes; internodes to 12.4 cm long, glabrous or with scattered capitate hairs, a line of uniseriate hairs always present. Leaves narrowly ovate; blades to 8.0 cm long, to 2.7 cm wide, complicate, with base rounded or sometimes cuneate, glabrous on both sides (rarely with a

few hairs dorsally), margin ciliate, apex acute; sheaths to 12.5 mm long, to 8.0 mm in diam., villous or with a few long hairs at the orifice, a line of uniseriate hairs extending down the side opposite the blade, otherwise glabrous or with scattered capitate hairs to 1 mm long. Inflorescences of 1-5 double cincinni borne terminally and in the axils of the upper leaves; peduncles to 14.1 cm long, always with scattered capitate hairs and with or without 1-2 lines of uniseriate hairs extending down the sides; double cincinni with up to 26 buds, flowers and/or fruits; pedicels to 7.0 mm long, reflexed in fruit, pilose or with scattered capitate hairs (Fig. 1); bracts at the base of each pedicel pilose or with scattered capitate hairs, margin partly, wholly, or not at all ciliate. Flowers pink or rarely white; sepals ovate-cymbiform, to 5.0 mm long, to 2.8 mm wide, green or with a red tip and/or base and/or margin, pilose or with scattered capitate hairs (Fig. 1) to 1 mm long, margin hyaline, apex more or less acute; petals obovate, to 6.0 (-8.6) mm long, to 4.8 mm wide, base cuneate, apex acuminate or irregularly indented; stamens in two whorls, the outer whorl shorter, filaments to 1.8 mm long, pink in the middle, white on the ends, bearing a tuft of moniliform hairs on the mid-portion of the dorsal side (Fig. 5), anthers 0.4-1.1 mm long, 0.4-1.2 mm wide, white with a purple line around the open sac, basifixed, anther sacs more or less parallel, pollen white; inner whorl of stamens longer, to 5.5 mm long, pink in the middle and white on both ends, glabrous, bent in an open S-shape and slightly expanded in the upper portion (Fig. 18), anthers 0.5-1.1 mm long, 0.5-1.4 mm wide, basifixed, connective inflated, bent, yellow, anther sacs divergent or nearly parallel through bending of the connective, pollen cream-colored; ovary 0.8-1.4 mm long, 0.6-1.4 mm in diam., green, glabrous, style 0.3-0.5 mm long, stigma simple, capitellate or capitate. Capsule obovate, 2.2-3.5 mm long, 1.8-4.0 mm in diam., green to light brown, glabrous; seeds two per locule, triangular, 1.2-1.8 (-2.1) mm long, brown, testa ribbed areolate (Figs. 50, 51, 54, 55), hilum punctiform (Figs. 51, 55).

In the past, plants of this species were identified as *Tripogandra disgrega*. As noted earlier, the holotype for *T. disgrega* is unmistakeable so another name must be applied to these plants. The next available name is *Tradescantia purpurascens* Schauer. The description accords well with *Aschenborn* 493 in the Berlin herbarium and because I have seen no other specimen I consider this to be the holotype. The description does not mention the stamens or seeds but dissection of the flowers proved the specimen to be *Tripogandra*. This specimen was seen by C. B. Clarke, annotated by him, and is cited apparently as "*Amberbeau* 493", under his description of *Tradescantia disgrega*. Several specimens of *T. purpurascens* were listed by him under *T. amplexicaulis*. He apparently did not have clear concepts of the species *T. amplexicaulis* and *T. disgrega*. He does not include the name *T. purpurascens* in his list of synonyms for *T. disgrega* or any other species. This omission is surprising considering the number of manuscript names that are included as synonyms in the various species he dealt with.

The separation of and differences between *Tripogandra disgrega* and *T. purpurascens* are discussed under the former species.

Tripogandra purpurascens is found in every country from México to Panamá, is absent from most of South America and occurs again in southern Bolivia and northern Argentina. This outlier is morphologically recognizeable by the presence of scattered capitate hairs on all the internodes. I recognize these plants as *T. purpurascens* subspecies *australis*. In all other respects it seems to be identical with the typical element of the species.

16a. **Tripogandra purpurascens** (Schauer) Handlos subsp. **purpurascens.**

Tradescantia minuta Clarke in DC., Monographiae Phanerogamarum 3:307. 1881. TYPE: **México.** *Uhde* 141a (Holotype, B!; isotype, L!).

Tradescantia parvula Brandegee, Univ. Calif. Publ. Bot. 6:51. 1914. TYPE: **México.** PUEBLA: Boca del Monte, Oct. 1913, *Purpus* 6486 (Holotype, UC!; isotypes, BM!, F!, GH!, MO!, NY!).

Descantaria minuta (Clarke) Brückner, Notizbl. Bot. Gart. Berlin-Dahlem 10:56. 1927.

Tripogandra minuta (Clarke) Woodson, Ann. Missouri Bot. Gard. 29:153. 1942.

Lower internodes glabrous except for a line of uniseriate hairs extending down one side, rarely the upper internodes with scattered capitate hairs.

Chromosome number: $n=16$.

Vernacular name: matlale fide Kerber, México.

Distribution and habitat: México, Guatemala, Honduras, El Salvador, Nicaragua, Costa Rica, Panamá; in seasonal stream beds or as a weed in cultivated fields at elevations from 990 to 2500 meters.

Flowering: In México flowering occurs from August to December while in Guatemala it occurs from September to January and occasionally in April and June. In the remainder of Central America flowering plants may be found from September to November in Honduras and El Salvador, December to February in Nicaragua, July to December in Costa Rica, and December to March in Panamá.

Flowers open about 10:00 AM and close about 12:45 PM.

REPRESENTATIVE SPECIMENS

México. CHIHUAHUA: base of Sierra Madre, 3 Oct. 1888, *Pringle* 1680 (BM, BR, L, M, UC). SINALOA: km. 1184 of Hwy. 40, 1.7 km. above Potrerillos, 1600 m., 15 Oct. 1967, *Handlos* 464 (BH). DURANGO: at the city of Durango and vicinity, 6297 ft., Apr.-Nov. 1896, *Palmer* 646 (BM, C, F, GH, MO, NY, US). ZACATECAS: Sierra de los Morones, near Plateado, Sept. 1897, *Rose* 2713 (NY, US). SAN LUIS POTOSI: Alvarez, 5-10 Sept. 1902, *Palmer* 139 (GH, MO, NY, US). NAYARIT: vicinity of Jalisco, 10 Nov. 1925, *Ferris* 5893 (DS, US). JALISCO: about 11 miles southeast of Lagos de Moreno, near highway to León,

1900 m., 7 Sept. 1952, *McVaugh* 12829 (MICH). HIDALGO: lower slopes of Mt. Leña, west of Leña Station (FCNM), Mun. Nopala, Dist. Huichapan, 2500 m., 10 Oct. 1946, *Moore, Jr.* 1441 (BH, GH). VERACRUZ: La Luz pr. Córdoba, 7 Oct. 1882, *Kerber* 90 (BM, C, GOET, M, US). MICHOACAN: sparsely to densely vegetated slopes of lava flow east of San Juan Nuevo, ca. 8 km. south of Uruapan, 6100 ft., 11-15 Oct. 1961, *King & Soderstrom* 4719 (MICH, NY, UC, US). MEXICO: Ixtapan, Dist. Temascaltepec, 1000 m., 19 Oct. 1932, *Hinton* 2231 (F, GH, MO, NY, US). DISTRITO FEDERAL: Mt. Guadalupe prés México, 24 Aug. 1865-66, *Bourgeau* 888 (BR, C, GH, K, L, M, NY, US). MORELOS: Las Guacamayas, Cuernavaca, 1800 m., 5 Aug. 1966, *Rebolledo V.* (MICH, MSC). PUEBLA: Laguna San Baltasar, vicinity of Puebla, 2135 m., 20 Sept. 1906, *Arsène* 327 (US). GUERRERO: Pilas, Dist. Mina, 1000 m., 24 Sept. 1937, *Hinton* 10712 (BR, GH, NY, POM, US). OAXACA: Santiago Huitzo, 5500 ft., 22 Oct. 1894, *Smith* 231 (GH). CHIAPAS: Milpa on the north edge of San Cristóbal las Casas, Municipio of San Cristóbal, 7100 ft., 25 Sept. 1965, *Breedlove* 12430 (DS, F, MICH). **Guatemala.** HUEHUETENANGO: 3 km. south of Huehuetenango, 1800 m., 30 Nov. 1962, *Williams, Molina R. & Williams* 22117 (F, NY). QUICHE: mts. east of Quiché, 2020 m., 20 Nov.-4 Dec. 1940, *Grant* 656 (F, GH p.p., MICH p.p.). SAN MARCOS: San Marcos, 2000 m., 17 June 1882, *Lehmann* 1609 (BM, US). QUEZALTENANGO: Quezaltenango, Sept. 1876, *Bernoulli & Cario* 781 (GOET). SOLOLA: mountain slopes above Lake Atitlán, about 3-5 km. west of Panajachel, 2100 m., 6-7 Dec. 1963, *Williams, Molina R. & Williams* 25378 (F, NY). CHIMALTENANGO: near Finca La Alameda, near Chimaltenango, 1830 m., 7 Dec. 1938, *Standley* 59029 (F). GUATEMALA: Finca Bretaña, road between Guatemala and Fiscal, 1200 m., 12 Dec. 1938, *Standley* 59667 (F). JALAPA: Laguna de Ayarza, 8000 ft., Sept. 1892, *Heyde & Lux* 3885 (GH, US). CHIQUIMULA: Volcán Quezaltepeque, 3-4 miles northeast of Quezaltepeque, 1500-2000 m., 8 Nov. 1939, *Steyermark* 31502 (F). SANTA ROSA: Laguna Los Pinos, below Cerro Redondo, 25 Oct. 1942, *Steyermark* 52168 (F, MO). **Honduras.** MORAZAN: Guamiles sobre las faldas noroeste de la Mt. Uyuca, cerca de Las Flores, drainage of the Río Yeguare, 1600 m., 20 Oct. 1948, *Molina R.* 1273 (F, GH, MO). **El Salvador.** LA LIBERTAD: rim of Volcán San Salvador, 1800 m., 22 Sept. 1946, *Williams & Molina R.* 10622 (GH, MICH, MO). **Nicaragua.** JINOTEGA: road to La Fundadora, entering at km. 142 from Managua, region of Santa María de Ostuma, 1400 m., 7 Dec. 1958, *Hawkes, Hjerting & Lester* 2197 (C, K). MATAGALPA: road to La Fundadora, cloud forest area north of Sta. María de Ostuma, Cordillera Central de Nicaragua, 1300-1500 m., Feb. 1963, *Williams, Molina R. & Williams* 24949 (F, NY). **Costa Rica.** ALAJUELA: Clairiere au rancho de l'Achiote (Poas), 2200 m., Nov. 1896, *Tonduz* 10765 (BR, US). SAN JOSE:

à San José, 1135 m., Oct. 1890, *Tonduz* 3047 (BR, M, US). CARTAGO: Cartago, 4250 ft., Nov. 1887, *Cooper* 5962 (GH, NY, US). **Panamá.** CHIRIQUI: Alto Lino, vicinity of El Boquete, 990 m., 3 Feb.-15 Mar. 1938, *Maurice* 743 (US).

The species *Tradescantia minuta* has confused various authors — Matuda (1956) for example, includes specimens of *Leptorhoeo* and *Murdannia* in his circumscription of it. Clarke's original description states that the staminal filaments are glabrous. One assumes from this that all six are glabrous and if one studies the dissected flower present on the holotype (*Uhde* 141a), this seems correct. The problem arises from the fact that the dissected flower is an immature one and the hairs on the filaments have not yet developed. An examination of flowers well past anthesis with nearly mature capsules reveals that the short filaments of the outer whorl are bearded and the longer filaments of the inner whorl are glabrous. The remainder of the description seems correct. *Uhde* 141a seems to represent a very reduced (depauperate) form of *Tripogandra purpurascens* subsp. *purpurascens*. The corrected observation of the presence of bearded filaments leaves no character by which to distinguish this material as a different species.

As Clarke erred in describing his new species with glabrous filaments, so T. S. Brandegee erred in describing the six filaments of his new species, *Tradescantia parvula*, as bearded. Again, a closer examination of the specimens reveals that the three short filaments are bearded but the three longer ones are glabrous. *Tradescantia parvula* represents another depauperate form of *Tripogandra purpurascens* subsp. *purpurascens*. Plants which have a strictly annual habit seem to be able to flower and produce seeds when of a very small size and with very few leaves. On the other hand some plants seem capable of producing long stems. In México, plants of *Handlos* 160 flowered at a height of 12.5 cm, but when seeds of these plants were grown in the greenhouse in Ithaca, N.Y., the seedlings reached a height of over a meter before flowering.

Throughout México this subspecies is relatively uniform in size considering the plasticity of annuals. The presence of one or two lines of uniseriate hairs on the peduncle is a sporadic character over much of México but in southern México and in Central America it becomes more common and is used as a key character by Standley and Steyermark in their Flora of Guatemala. There is still variability — some plants lack the line — but the frequency of occurrence is much higher than in México north of Chiapas.

The colonizing and weedy propensities of *Tripogandra purpurascens* subsp. *purpurascens* should be noted. Plants of this subspecies probably existed in stream beds and naturally disturbed areas such as those around volcanoes prior to man's invasion of the ecosystem. Often I have seen *T. purpurascens* subsp. *purpurascens* in seasonal stream beds and on August 19, 1965, on a trip to the volcano of Paricutín, I found plants of subsp. *purpurascens* growing within ten meters of the edge of a lava flow. The area had been covered with a layer of volcanic ash but the plants were growing, flowering and producing seeds under these conditions. Volcanic activity has occurred extensively and for a long period of time in México. Clausen (1959) has designated the central, volcanically active area of México as the Trans-Mexican Volcanic Belt. The weedy habit in this species probably could have existed before the advent of man and his disturbances of the natural vegetation but man must be credited for opening additional areas for colonization by this species and allowing it to become the most common species of *Tripogandra* in México.

16b. **Tripogandra purpurascens** (Schauer) Handlos subsp. **australis** Handlos, *subsp. nov.* TYPE: **Bolivia.** Toldos bei Bermejo, 1850 m., 26 Nov. 1903, *Fiebrig* 2221 (Holotype, GH!; isotypes, K!, L!, M!).

Illustrations: Bacigalupo, Darwiniana 13:402. 1967, Figs. 2, 5a-g, as *T. disgrega.*

Internodia pilis capitatis, dispersis pubescentia. In Bolivia australi et Argentina boreali indigena.

Internodes all with scattered capitate hairs and a line of uniseriate hairs.

Distribution and habitat: southern Bolivia and northern Argentina; in wet wooded areas or as a weed in disturbed places at elevations from 450 to 1850 meters.

Flowering: In January, February and March in Argentina.

REPRESENTATIVE SPECIMENS

Bolivia. *Fiebrig* 2221 (GH, K, L, M). **Argentina.** SALTA: Dept. Gen. M. Güemes, camino de La Cornisa, between Jujuy and Salta, at km. 1648.9, 1480 m., 18 Mar. 1966, *Hawkes, Hjerting & Rahn* 3909 (C). TUCUMAN: Cuesta del Garabatal, Sierra de Ende, Jan. 1874, *Lorentz & Hieronymus* 875 (CORD, E, F, GOET).

17. **Tripogandra saxicola** (Greenman) Woodson, Ann. Missouri Bot. Gard. 29:154. 1942.

Tradescantia saxicola Greenman, Proc. Amer. Acad. Arts 39:70. 1903. TYPE: **México.** GUERRERO: Iguala Cañon, 14 Sept. 1900, *Pringle* 9270 (Holotype, GH!; isotype, VT!).

Descantaria saxicola (Greenman) Brückner, Notizbl. Bot. Gart. Berlin-Dahlem 10:56. 1927.

Plants annual, erect or with the lower portion decumbent, rooting at lower nodes; stems to 31 cm long, unbranched to branched at every node; internodes 0.1-7.4 cm long, green or purplish-tinged at the base of the plant, a band of uniseriate hairs extending from the sheath above to the node below, otherwise variously glabrous to pilose. Leaves narrowly ovate to ovate; blades 1.0-7.4 cm long, 0.1-2.0 cm wide, glabrous dorsally, ventrally variously glabrous, pilose along the midvein, or pilose over the entire surface, base cuneate or truncate, margin ciliate; sheaths 1.0-5.0 mm long, 1.2-5.0 mm in diam. when dry, villous at the orifice, a line of uniseriate hairs extending down the side opposite the blade, otherwise glabrous or with a few scattered uniseriate hairs. Inflorescences few, borne terminally and in

the upper leaf axils; peduncles to 5.9 cm long, or so reduced that the double cincinni appear sessile, glabrous except for one or two lines of uniseriate hairs extending down the side; double cincinni with 1-10 flowers; pedicels 2.2-5.5 mm long, 0.3-0.6 mm in diam., pilose to densely pilose (Fig. 2), reflexed in fruit; bracts at the base of each pedicel usually ciliate. Flowers white; sepals ovate-cymbiform, 2.0-4.6 mm long, 1.3-2.4 mm wide, green, sparingly pilose to densely pilose, apex acute to obtuse, margin entire, hyaline; petals elliptic-ovate, ca. 2.5-5.8 mm long, ca. 2.0-4.5 mm wide, tapering at the base, apex obtuse; stamens 6, in two whorls, those of the outer whorl shorter, filaments 1.0-1.6 mm long, glabrous (Fig. 12), anthers 0.6-1.0 mm long, 0.3-0.7 mm wide, basifixed, versatile with parallel white anther sacs which are longer than the gibbous white connective, pollen white; stamens of the inner whorl longer, slightly epipetalous, filaments 2.0-4.5 mm long, bearded on the dorsal distal surface, with white moniliform hairs (Fig. 20), connective U-shaped, 0.3-0.7 mm long, 0.3-0.9 mm wide, yellow, dorsifixed, versatile, with yellow divergent anther sacs, pollen yellow; ovary 0.7-1.1 mm long, 0.6-1.1 mm in diam., green, glabrous, style 0.2-0.4 mm long, stigma capitellate. Capsule glabrous, brown, 2.5-2.7 mm long; seeds usually 6, 0.9-1.3 mm long, triangular or triangular with a notch in one end, with 2-3 furrows on the hilar side forming 3-4 lobes, brown to gray-brown, surface areolate (Fig. 56), hilum punctiform (Fig. 57) to elliptical.

Chromosome number: $n=21$.

Distribution and habitat: in the states of Guerrero, Morelos, and Puebla, México; in thin soil in rocky areas or under shrubs at elevations from ca. 840 to 1500 m.

Flowering: Flowers open about 3:00 PM and close about 5:00 PM. Therefore, this species appears to be unique among the Mexican *Tripogandra* species because it is the only one in which the flowers open in the afternoon; all other species flower in the morning even though blossoms may not close until afternoon.

REPRESENTATIVE SPECIMENS

México. MORELOS: Yautepec, near Cuernavaca, 22 Oct. 1902, *Pringle* (VT). PUEBLA: km. 216 on road to Oaxaca, Hwy. 190, about 16 km. SE of Izúcar de Matamoros, 30 Aug. 1965, *Handlos* 215 (BH). GUERRERO: Cañon del Mano, along railroad tracks north of Iguala, ca. 3 km. north of El Naranjo, ca. 840 m., 13 Sept. 1967, *Handlos* 418 (BH).

The origin of the annual habit may be illustrated by the growth cycle of *Tripogandra saxicola*. In México this species acts as an annual. All collections seem to be of the current season's growth judging from the presence of juvenile leaves at the base of the plant and the absence of old trailing stems and interconnections between plants. In the greenhouse, however, plants of *Handlos* 215 have functioned as perennials. The plants lose most of their leaves during the winter, though flowering continues, and some of the stems remain green. In May and June, vegetative shoots are produced, the plants grow vigorously, rooting at the nodes, and vegetative reproduction is very easy. However, not all collections react in this fashion. Plants of *Handlos* 415 acted as annuals in the greenhouse and died completely after flowering and producing seeds in 1967 and 1968. This behavior seems significant as it indicates that both the annual and perennial habit may exist within some species. With the extinction of all the perennial plants the species would appear strictly annual. The presence of annual and perennial populations also occurs in *Tripogandra serrulata* and may indicate that the annual habit has arisen independently several times within the genus and that some annual species may be of recent origin.

The collections *Handlos* 198 and 419 merit mention because these plants were collected in the same area in two different years. In 1965, when *Handlos* 198 was collected, the area was covered with large shrubs and small trees and had received enough rain so the ground was moist and water dripped from the ledges. Plants reached a maximum height of 31 centimeters and were found only

after crawling under and through the bushes. Two years later I found the whole area cut over, apparently for firewood, with very little brush left. It was then possible to walk and climb over the rocks with little interference from the remaining woody vegetation. The plants collected as *Handlos* 419 were wilted, what little soil was left was exceedingly dry, and the few individuals which were found reached a maximum height of only 15 centimeters. This information not only gives an impression of how much variation may occur in an area from year to year but it also gives us a glimpse of the fate of the plants in this area. First, there is a diminution of plant size; second, there is a reduction in population size, and lastly, extinction is probable as the soil is gradually washed away from the rocky ledges and weedy plants which are better competitors grow in the alluvium deposited at the cliff bases.

18. **Tripogandra serrulata** (Vahl) Handlos, Baileya 17:33. 1970.

Commelina serrulata Vahl, Eclogae Americanae 2:4. 1798. HOLOTYPE: *Ryan* (C!).

?*Tradescantia elongata* Meyer, Primitae Florae Essequeboensis . . . 146. 1818. HOLOTYPE: apparently lost.

Tradescantia congesta Martens & Galeotti, Bull. Acad. Bruxelles 4(2):377. 1842. HOLOTYPE: **México.** VERACRUZ: Mirador, 3000 ft., June-Oct. 1840, *Galeotti* 4949 (BR!).

Tradescantia balbisii Kunth, Enumeratio Plantarum 4:97. 1843. TYPE: Portorico, 1834, *Balbis* (Holotype, B!; isotype, B!).

Tradescantia schlechtendalii Kunth, Enumeratio Plantarum 4:94. 1843. TYPE: **México.** Hacienda de la Laguna, Oct. 1828, *Schiede* 972 (Holotype, B!; isotype, HAL!).

Tradescantia schomburgkiana Kunth, Enumeratio Plantarum 4:663. 1843. TYPE: Guiana Angl., 1842, *Schomburgk* 189 (Holotype, B!; isotype, K!).

Tradescantia guianensis Miquel, Linnaea 18:374. 1845 ('1844'). TYPE: **Surinam.** *Focke* 400 (Holotype, U!; isotype, GH!).

Descantaria ?balbisii Hasskarl ex Clarke in DC., Monographiae Phanerogamarum 3:303. 1881, *nom. nud. pro syn.*

Descantaria schlechtendalii Hasskarl ex Clarke in DC., Monographiae Phanerogamarum 3:304. 1881, *nom. nud. pro syn.*

Heterachtia gaudichaudiana Hasskarl ex Clarke in DC., Monographiae Phanerogamarum 3:303. 1881, *nom. nud. pro syn.*

Tradescantia cumanensis β glabrior Clarke in DC., Monographiae Phanerogamarum 3:306. 1881. TYPE: **Nicaragua.** Chontales, 1867-8, *Tate* 452 (Holotype, K!; isotype, BM!).

Tradescantia elongata δ schlechtendalii (Kunth) Clarke in DC., Monographiae Phanerogamarum 3:304. 1881.

?*Descantaria elongata* (Meyer) Brückner, Notizbl. Bot. Gart. Berlin-Dahlem 10:56. 1927.

?*Tripogandra elongata* (Meyer) Woodson, Ann. Missouri Bot. Gard. 29:152. 1942.

Tripogandra cumanensis f. *glabrior* (Clarke) Standley & Steyermark, Fieldiana: Bot. 24(3):36. 1952.

Illustrations: Standley and Steyermark, Fieldiana: Bot. 24(3):39, 1952, Fig. 9, a line drawing of a flower and upper part of the plant. The position of the stamens is incorrectly shown in the open flower and misplaced in the flower drawing.

Plants perennial, decumbent at the base, rooting at nodes, flowering stems erect; stems to 1.14 m long, branching irregularly; internodes to 14.1 cm long, glabrous except for a line of uniseriate hairs extending down the side from the sheath above (Fig. 4). Leaves narrowly ovate, occasionally ovate; blades to 13.2 cm long,

to 2.7 cm wide, glabrous to pilose dorsally, rarely with a line of hairs along the midvein, glabrous to sparingly pilose ventrally, often with a line of uniseriate hairs along the midvein, base oblique, margin ciliate, apex acute; sheaths to 2.1 cm long, to 1.2 cm in diam., villous at the orifice, a line of uniseriate hairs extending down the side opposite the blade (Fig. 4), otherwise variously glabrous or the uppermost occasionally with scattered uniseriate hairs or pilose. Inflorescences composed of 1-13 double cincinni borne terminally and in the axils of the upper 1-4 leaves; peduncles 0.4-5.1 (-6.7) cm long, glabrous or with 1-2 lines of uniseriate hairs extending down the sides; double cincinni with up to 17 buds, flowers and/or fruits; pedicels 0.7-5.0 mm long, 0.5-0.7 mm in diam., reflexed in fruit, glabrous to sparingly pilose (Fig. 3), hairs capitate; bracts at the base of each pedicel glabrous, margin entire, ciliate, or with a few scattered hairs. Flowers white or pink (Fig. 16); sepals ovate, 2.5-4.6 mm long, 1.3-2.7 mm wide, glabrous to sparingly pilose (Fig. 3), hairs capitate, margin hyaline, apex acute to obtuse; petals ovate-elliptic, 3.5-6.2 mm long, 2.3-4.3 mm wide, base cuneate, apex rounded; stamens 6 in two whorls, the outer shorter, filaments 1.0-1.5 mm long, white, glabrous or with a few (1-3) moniliform hairs, anthers 0.5-1.0 mm long, 0.4-1.0 mm wide, anther sacs parallel, connective inconspicuous, pollen white; stamens of the inner whorl longer, filaments 2.7-4.5 mm long, white, bent in an open S-shape, bearded with moniliform hairs in the upper half (Fig. 19), anthers 0.4-0.8 mm long, 0.5-1.0 mm wide, basifixed, connective elongate and narrow, anther sacs divergent, yellow, pollen yellow; ovary 0.6-1.3 mm long, 0.5-1.0 mm in diam., white, glabrous, style 0.1-0.3 mm long, stigma capitate, weakly 3-lobed. Capsule elliptical, 2.0-2.8 mm long, 1.5-2.5 mm in diam., light brown, glabrous; seeds usually 2 per locule, rounded triangular, 0.9-1.5 mm long, gray or brownish-gray, testa reticulate, reticulations lighter in color (Fig. 38), hilum punctiform (Fig. 39).

Chromosome number: $n=16$, 24.

Vernacular names: suelda fide Bro. Daniel, Colombia; siempre viva fide Archer, Colombia; palm grass (Barbadian) fide Standley, Panamá; matalin, shiú fide Martínez-Calderón, México; yerva del poyo fide Curtiss, México.

Distribution and habitat: central México, south to Panamá, Colombia, Ecuador, Perú, Venezuela, Guyana, Surinam, and the Caribbean islands; from sea level to about 1500 m. Most specimens with altitudinal information are from intermediate to low elevations. Two records are exceptions. Matuda reports 2500 meters for one location in México, while Heyde and Lux reported 8000 feet for a collection in Guatemala. These reports should be investigated further.

Flowering: in México from January to December; in Guatemala from August to January and March, May, and July; in British Honduras from October to February and April; in Honduras from November to March and May, June, August, and September; in El Salvador from December to April and July; in Nicaragua in April and December; in Costa Rica in every month except January; in Panamá in every month of the year; in Colombia in February, March, April, May, June, August, October, November, and December; in Ecuador in May and August; and in Perú in April.

Flowers open in the morning about 9:00 AM and close about 2:30 PM.

REPRESENTATIVE SPECIMENS

México. SAN LUIS POTOSI: Tamazunchale, 250 ft., 5 Aug. 1937, *Fisher* (MO, NY, US). HIDALGO: wooded slopes between Calnali and Huazalingo, Dist. Huejutla, 29 May 1947, *Moore, Jr.* 3016 (BH). VERACRUZ: Orizaba, Mt. Orizaba, 4000 ft., 29 Aug. 1891, *Seaton* 29 (F, GH, NY, US). DISTRITO FEDERAL: Monte Guadalupe près México, 24 Aug. 1865, *Bourgeau* 888 (GH). MORELOS: Cuernavaca, 29 Oct. 1903, *Holway* 5261 (GH). PUEBLA: near Metlaltoyuca, 800 ft., 31 Jan. 1898, *Goldman* 49 (US). OAXACA: Yaveo, Arroyo del Perrico, Dist. Choapam, 475 m., 15 Mar. 1938, *Mexia* 9153 (F, GH, MO, NY, U, UC, US). CHIAPAS: Escuintla, Nov.-Dec. 1937, *Matuda* 2176 (F, GH, MICH, NY, UC). **Guatemala.** ALTA VERAPAZ: Finca Mocca, 3200 ft., 5 Jan. 1920, *Johnson* 169 (NY, US). IZABAL: vicinity of Quiriguá,

75-225 m., 15-31 May 1922, *Standley* 24165 (GH, NY, US). SAN MARCOS: river 5 mi. W of Malacatan, 400 m., 20 Nov. 1940, *Grant* 566 (F, GH). QUEZALTENANGO: Finca Pireneos, below Santa María de Jesús, 1350-1380 m., 11 Mar. 1939, *Standley* 68347 (F, MICH). SACATEPEQUEZ: Ciudad Vieja, Mar. 1915, *Tejada* 343 (US). GUATEMALA: Breñas y seta cerca de Guatemala, 1400 m., July 1921, *Tonduz* 669 (US). JALAPA: Laguna de Ayarza, 8000 ft., Oct. 1892, *Heyde & Lux* 3882 (GH, K, M, US). ZACAPA: Gualán, 420 ft., 20 Jan. 1905, *Deam* 404 (GH, MICH). RETALHULEU: San Felipe, 13 Jan. 1917, *Holway* 710 (US). SUCHITEPEQUEZ: Chojoja p. Mazatenango, Sept. 1867, *Bernoulli* 469 (BR, NY). ESCUINTLA: Escuintla, 1100 ft., Mar. 1890, *Donnell-Smith* 2220 (GH, M, US). SANTA ROSA: Río María Linda, 3000 ft., Sept. 1893, *Heyde & Lux* 6251 (GH, US). SAN MARCOS: Cangutz, 1140 m., 31 July 1922, *Galas* 11 (US). **British Honduras.** Gracie Rock, Sibun River, 15 April 1935, *Gentle* 1594 (F, GH, MICH, MO, NY, US). **Honduras.** SANTA BARBARA: Río Permejo, 600 ft., Dec. 1888, *Thieme* 5532 (GH, US). CORTES: in ravine near Lake Yojoa, Agua Azul, 630 m., 28 Dec. 1946, *Williams & Molina R.* 11411 (BH, GH, MICH, MO, UC). COMAYAGUA: Rittenhouse's hacienda near Siguatepeque, 1050 m., 30 June 1936, *Yuncker, Dawson & Youse* 5527 (F, GH, MICH, MO, U). ATLANTIDA: Ceiba, 26 Sept. 1916, *Dyer* A94 (US). YORO: Farm 39 of the Tela Railroad Company, Guaymas Dist., 30 m., 2 Feb. 1928, *Standley* 55489 (US). OLANCHO: a la orilla de la quebrada cerca de El Plomo, Valle Catacamas, 300 m., 19 Nov. 1963, *Molina R.* 13290 (G, NY). LEMPIRA: faldas de Montaña Puca cerca de Los Cuábanos, 1300 m., 25 Sept. 1963, *Molina R.* 12956 (F, NY). MORAZAN: along Santa Clara Creek, drainage of the Río Yeguare, 850 m., 6 Aug. 1949, *Williams & Molina R.* 15865 (GH, US). EL PARAISO: Montaña entre Cifuentes y El Urraco, 900 m., 15 Mar. 1963, *Molina R.* 11428 (F, NY, US). **El Salvador.** AHUACHAPAN: vicinity of Ahuachapán, 800-1000 m., 9-27 Jan. 1922, *Standley* 19838 (GH, NY, US). SONSONATE: Finca Chilata, 26, 27 Dec. 1921, *Standley* 19311 (GH, NY, US). LA LIBERTAD: vicinity of Santa Tecla, 790-950 m., 10 Apr. 1922, *Standley* 23054 (US). SAN SALVADOR: San Salvador, July 1922, *Calderón* 913 (GH, MO, NY, US). LA PAZ: Zacatecoluca, Mar. 1922, *Calderón* 303 (GH, NY, US). SAN VICENTE: vicinity of San Vicente, 350-500 m., 2-11 Mar. 1922, *Standley* 21727 (GH, MO, NY, US). **Nicaragua.** JINOTEGA: road to La Fundadora, entering at km. 142 from Managua, region of Santa María de Ostuma, 1400 m., 7 Dec. 1958. *Hawkes, Hjerting & Lester* 2198 (C). CHONTALES: slopes of Mt. Mombacho, near Grenada, 460 m., 18 Dec. 1940-9 Feb. 1941, *Grant* 787 (F, GH, MICH). ZELAYA: vicinity of El Recreo, on Río Mico, ca. 30 m., 23 Apr.-14 May 1949, *Standley* 19091 (F). **Costa Rica.** ALAJUELA: Villa Quesada, Canton San Carlos, 825 m., 10 Mar. 1940, *Smith* p2574 (F, MICH, MO). SAN JOSE: vicinity of

El General, 915 m., Feb. 1936, *Skutch* 2602 (GH, MICH, MO, NY, US). CARTAGO: Angostura, 19 June 1874, *Kuntze* 2050 (NY). LIMON: Jiménez, Llanos de Santa Clara, 650 ft., Apr. 1894, *Donnell-Smith* 4976 (GH, K, US). **Panamá.** BOCAS DEL TORO: Bocas del Toro, 6 Nov. 1920, *Carleton* 71 (GH, NY, US). CHIRIQUI: Boquete, Boquete Dist., 3800 ft., 17 May 1938, *Davidson* 665 (F, GH, MO, US). COCLE: Lower Río Anton, vicinity of El Valle De Anton, 800-1000 (600) m., 30 Dec. 1936, *Allen* 111 (GH, MO, PH). CANAL ZONE: ruins of fort, Fort San Lorenzo, Fort Sherman Military Reservation, 14 June 1923, *Maxon & Valentine* 7018 (C, GH, US). PANAMA: Tumba Muerto Road, near Panamá, 6 Jan. 1924, *Standley* 29717 (C, US). DARIEN: vicinity of Boca de Cupe, ca. 40 m., 5 Oct. 1938, *Allen* 890 (F, GH, MO, NY, US). SAN BLAS: Perme, 24 Apr. 1933, *Cooper III* 253 (NY, US). **Venezuela.** CARABOBO: Represa del acueducto de San Esteban, Pto. Cabello, 7 Jan. 1965, *Aristeguieta* 5421 (VEN). ARAGUA: entre Guamilas y Rancho Grande, P.N., 850 m., 6 Oct. 1938, *Williams* 10382 (VEN). FEDERAL DISTRICT: Caracas and vicinity, 3000-3500 ft., 9 Jan. 1921, *Bailey & Bailey* 811 (NY, US). MIRANDA: bosque de Los Guayabitos, arriba de Baruta, Nov. 1964, *Aristeguieta* 5395 (VEN). MERIDA: 3½ miles west of city of Mérida, 5000 ft., 24 Jan. 1931, *Reed* 288 (US). BOLIVAR: San José, Ciudad Bolívar and vicinity, on the Orinoco, about 200 ft., 9 Jan. 1921, *Bailey & Bailey* 811 (BH). **Colombia.** MAGDALENA: Minca road, Santa Marta, 1200 ft., 23 Nov. 1898-1899, *Smith* 2280 (BM, BR, E, F, GH, L, MICH, MO, NY, PH, U, UC, US, VT, WIS). BOLIVAR: Los Hurtados, on Río Sinu, 40-70 m., 4 Feb. 1918, *Pennell* 4153 (NY, US). CHOCO: Andagoya, 70-100 m., 20-30 Apr. 1939, *Killip* 35075 (BM, MO, US). ANTIOQUIA: vicinity of Medellín, 10 Mar. 1927, *Toro* 37 (NY, US). SANTANDER: Puerto Wilches and vicinity, 100 m., 28 Nov.-2 Dec. 1926, *Killip & Smith* 14773 (NY). VALLE DEL CAUCA: Estero de Congrejo, north shore of Buenaventura Bay, near sea level, 3 June 1944, *Killip & Cuatrecasas* 38730 (F, US). CALDAS: Santa Cecilia, Cordillera Occidental, Vertiente Occidental, 800 m., 16 Feb. 1945, *von Sneidern* 5181 (US). TOLIMA: "La Trinidad," Libano, 1000-1200 m., 21-25 Dec. 1917, *Pennell* 3363 (NY). **Ecuador.** PICHINCHA: entre Santo Domingo y la Hcda. Lelia, Sección Occidental, 400-800, 950-1100 m., 11 Aug. 1945, *Acosta-Solís* 10937 (F, US). IMBABURA: entre El Pajón y Cachaco, 600, 740 m., 30 May-12 June 1949, *Acosta-Solís* 12728 (F, US). **Perú.** TUMBES: a 8 km. al sur de Tumbes, 15-20 m., 24 Apr. 1949, *Ferreyra* 6002 (US). LORETO: near km. 194 below Divisoria on road from Tingo Maria to Aguaytia, Prov. Coronel Portillo, ca. 1400 m., 22 Dec. 1960, *Moore, Jr., Salazar C. & Smith* 8632 (BH). JUNIN: La Merced, ca. 700 m., 29 May-4 June 1929, *Killip & Smith* 23416 (NY, US). **Guyana.** POMEROON DISTRICT: Mora Landing, Moruka River, 21-23 Aug. 1922, *De La Cruz* 1844 (BH, F, GH, MO, NY, US). **Surinam.**

Suriname R. near Gansee, 15 Nov. 1933, *Lanjouw* 1307 (NY, U, US). **Dominican Republic.** Madre Vieja, Nagua, Prov. Maria Trinidad Sánchez, 20 Dec. 1964, *Jimenez* 5108 (NY). **Puerto Rico.** San Juan, 14 km. S on Mil. Road, 2 Mar. 1899, *Heller & Heller* 662 (F, NY, US). **Guadeloupe.** 1895, *Duss* 3619 (F, NY, US). **Dominica.** prope Wotten Waven, 200 m., Dec. 1887, *Eggers* 690 (BR, CORD, GOET, L, M, UC). **Martinique.** La riviere du Galion (Trinite) et de la riviere du Carbet, Oct. 1888, *Duss* 1024 (NY). **St. Vincent.** 1000 ft., March 1890, *Smith & Smith* 1660 (BM). **Trinidad.** North Range, roadside forest, Arima Valley Road, 500 m., 24 Mar. 1959, *Cowan & Simmonds* 1180 (NY, US).

Tripogandra serrulata may be easily distinguished from other species by its gray or gray-brown seeds with lighter colored reticulations which produce a cobweb pattern over the surface.

Within *Tripogandra serrulata* there is variation in leaf shape as well as in the vesture of leaves, peduncles, pedicels, and sepals. I have not seen any consistency or pattern in this variation. This does not of necessity mean that none exists, however, only that my study has not been precise enough and that the information available to me has not been complete.

Many of the specimens associated with this species have been identified in the past as *Tripogandra cumanensis.* This seems to be the result of a misidentification of specimens by Clarke. The name which has priority is *Commelina serrulata. Tradescantia cumanensis* is cited as a synonym of *Tripogandra multiflora* and is discussed under that species.

Vahl's description of *Commelina serrulata* agrees well with the type specimen, but does not mention the stamens or the seeds. It would be difficult to know from the description alone to which species or even genus this specimen should be referred. The specimen has nearly mature seeds which have a reticulation matching that on plants which recent taxonomists have called *Tripogandra cumanensis.* The stamens follow the diagnostic *Tripogandra* pattern; they are dimorphic with the shorter ones opposite the

sepals. It was probably because of the dimorphic stamens that Vahl placed this species in the genus *Commelina*. The name *Commelina serrulata* has not been used in recent years but the type specimen is undoubtedly a *Tripogandra*. Kunth (1843) included this species in the genus *Commelina* in a section called "Species valde dubiae," indicating that he was not certain what the plant was. His decription was taken from Vahl and in parts is nearly a word-for-word copy, implying that he had probably not seen a specimen.

The problem of the identity of *Tradescantia elongata* has plagued taxonomists for many years. I have not seen the type specimen; it should be a Rodshied collection (Stearn and Williams, 1957) preserved at Göttingen but was not located among the specimens obtained on loan. If *T. elongata* does actually apply to *Tripogandra* it can only apply to the one taxon which seems to occur in the vicinity of the Essequibo River in Guyana. The plants from this area are of great interest and should be studied further. I have examined sixty-one sheets of specimens from this area; all sheets have several inflorescences but none of them have fruits in any stage of development. In addition I mounted pollen in aniline blue-lactophenol from some of the plants identified as *T. elongata* from throughout its range. The pollen does not stain and on that basis is considered to have been inviable when fresh. From personal experience with *T. serrulata* in México and knowledge of the existence of sterile plants within these populations, I have treated all these sterile collections as part of the species *T. serrulata*, but only after studying and describing that species from fertile specimens. The pattern and range of variation within the sterile collections falls within that of fertile plants of *T. serrulata*, except for the peduncle length of three collections from Guyana. The longest peduncles were 5.7, 6.4, and 6.7 cm. while the longest peduncle on fertile *T. serrulata* was 5.1 cm. I do not consider this problem solved. The apparent sterility of these plants must be studied in the field to see if it is characteristic or whether my sample by some quirk is very biased.

Tripogandra elongata has been interpreted broadly in the past and three taxa have been included within it. These are *T. diuretica* of southern Brazil, Bolivia, Paraguay, Agentina, and Uruguay, *T. montana* of Central America, and *T. elongata* sensu stricto of eastern Venezuela, Guyana and Surinam. These three taxa are not sympatric in any part of their ranges and are morphologically distinguishable. Therefore, I prefer to recognize *T. diuretica* and *T. montana* as separate and distinct species, while the sterile plants of *T. elongata* are included within *T. serrulata*.

Kunth (1843) proposed the name *Tradescantia schlechtendalii* based on *Schiede* 972, which Schlechtendal had misidentified and called *Commelina mexicana* Presl. Presl's original description contains several points indicating that the plants were different: "Petala caerulea, . . . Stamina tria. Filamenta erecta fertilia hirsuta, duo pistillo breviora, tertium pistillo longius. Antherae . . . apice poro dehiscentibus polliniferia . . . Stylus simplex curvatus. Stigma emarginatum." The Schiede specimen has white petals, six stamens, three longer and three shorter, and a capitate stigma. Kunth proceeded, however, to recognize *Commelina mexicana* Presl as a species of *Tradescantia*. I believe that this name may apply to a species of *Commelina* though I am not certain of this. In any case it certainly is not a species of *Tradescantia* or *Tripogandra*, on the basis of the description given by Presl.

Clarke's variety *β glabrior* of *Tradescantia cumanensis* does not seem to differ from *T. congesta*. Clarke states that the pedicels and sepals are glabrous when, in fact, there are a few hairs to be found on the type specimen though some structures are glabrous. These two collections are certainly conspecific but Clarke considered *glabrior* to be a variety of *T. cumanensis* while *T. congesta* was made a synonym of *T. elongata*.

Plants of *Tripogandra serrulata* have been collected from several Caribbean islands. All of these collections lack seeds except one from Hispaniola. The seeds seem identical

with those of mainland *T. serrulata*. If this plant represents the native and not a recently introduced *Tripogandra*, this gives me further confidence in considering these plants, which have been called *T. elongata*, as conspecific with *T. serrulata*.

19. **Tripogandra silvatica** Handlos, *sp. nov.* TYPE: **México.** VERACRUZ: Montepio, 19 km. al E de Catemaco, 19 Mar. 1965, *Gonzales Quintero* 2239 (Holotype, MICH!; isotype, MSC!).

Herba perennis(?); *caulis* decumbens, usque ad 30 cm longus; *internodiis* usque ad 5.5 cm longis, linea unica pilorum instructis, aliter glabris. *Folia* ovata, laminis usque ad 2.9 cm longis, usque ad 1.4 cm latis, basi obliquis, apice acutis, dorsaliter glabris, ventraliter glabris vel pilis dispersis instructis praeter lineam partialem pilorum secus costam, margine ciliatis, vaginis usque ad 5.6 mm longis, usque ad 3.0 mm diam., orificio villosis vel pilis dispersis praeditis, linea unica pilorum instructis, aliter glabris. *Inflorescentiae* terminales, ex 1 (-3) cincinnis duplicibus constantes; *pedunculi* usque ad 2.3 cm longi, glabri vel pilis capitatis paucis dispersis instructi; *cincinni* duplices omnes alabastra, flores, vel fructus usque ad 13 gerentes; *pedicelli* usque ad 4.5 mm longi, maturitate reflexi, glabriusculi ad pilosi, bracteis basi pedicellorum glabris, margine erosis, nonnunquam ciliatis. *Flores* albi; *sepala* ovata, cucullata, usque ad 3.7 mm longa, usque ad 1.6 mm lata, pilis capitatis pilosa, margine hyalina, apice ± obtusa; *petala* usque ad 4 mm longa; *stamina* 6 in verticillis duobus, 3 sepalis opposita filamentibus brevibus, usque ad 1.3 mm longis, glabris vel ?pilis paucis moniliformibus praeditis, antheris usque ad 0.5 mm longis, usque ad 0.6 mm latis, 3 petalis opposita filamentibus longioribus, usque ad 2.7 mm longis, glabris, distaliter sigmoideis, antheris usque ad 0.7 mm longis, usque ad 0.6 mm latis; *ovarium* usque ad 0.7 mm longum, glabrum, stylo usque ad 0.4 mm longo, stigmate capitellato. *Capsula* obovoidea, usque ad 2.3 mm longa, usque ad 1.5 mm diam., glabra, basi stipitata,

seminibus triangularibus, usque ad 1.2 mm longis, reticulatis, hilo punctiformi.

Distribution and habitat: in the state of Veracruz, México, in the area around Colipa-Misantla and Catemaco; in wet forest lowlands.

Flowering: March and April.

SPECIMENS EXAMINED

México. VERACRUZ: Misantla, Mar. 1841, *Liebmann* (C); inter Colipa et Misantla ad Palenque, Mar. 1841, *Liebmann* (C); Colipa, Mar. 1841, *Liebmann* 350 (C); Colipa, Mar. 1841, *Liebmann* (C); Jalapa, 4000 ft., 3 Apr. 1899, *Pringle* 7810 (VT).

Dried specimens of this species resemble *Leiandra cordifolia* superficially — usually bearing only one terminal double cincinnus. Dissection of the flower is necessary to reveal the dimorphic nature of the stamens.

20. **Tripogandra warmingiana** (Seubert) Handlos, *comb. nov.*

Tradescantia warmingiana Seubert in Warming, Vidensk. Meddel. Dansk Naturhist. Foren. Kjøbenhavn 126. 1872. HOLOTYPE: **Brazil.** MINAS GERAIS: Lagoa Santa, 6 Mar. 1866, *Warming* 1046 (C!).

Plants annual(?); stem decumbent at the base and rooting at the nodes, to 19 cm long, branched; internodes to 5.6 cm long, glabrous except for a line of uniseriate hairs extending down the side from the sheath above. Leaves narrowly ovate to ovate; blades to 4.4 cm long, to 1.85 cm wide, with the base always oblique but narrowed and subpetiolate on the lower part of the plant, glabrous dorsally, glabrous ventrally except for a line of hairs at the proximal end of the midvein, margin ciliate, apex acute and slightly acuminate; sheaths to 4.4 mm long, to 3.1 mm in diam., sparingly villous at the orifice, otherwise glabrous except for a line of uniseriate hairs extending down the side opposite the blade. Inflorescences composed of 1-3 double cincinni borne terminally and in the upper leaf axils; peduncles to 1.2 cm long, green, glabrous; double cincinni

with up to 8 buds, flowers and/or fruits, pedicels to 4.5 mm long, green, with a few uniseriate hairs near the distal end, reflexed in fruit; bracts at the base of each pedicel glabrous, margin erose. Flowers white; sepals ovate, to 3.4 mm long, to 1.7 mm wide, pilose along the midvein, the remainder with scattered uniseriate hairs, margin hyaline, apex acute; petals ovate-elliptic (fide Warming), to 5.0 mm long, to 2.3 mm wide, apex obtuse (fide Warming); stamens 6, in two whorls, the outer shorter, filaments to 1.2 mm long, glabrous, anthers to 0.7 mm long, to 0.5 mm wide, anther sacs parallel; stamens of the inner whorl longer, filaments to 3.7 mm long, bent in an S-shape (fide sketch, presumably by Warming), bearded in the lower portion of the upper half with moniliform hairs, anthers to 0.5 mm long, to 1.2 mm wide, connective elongate and anther sacs divergent; ovary to 0.9 mm long, 0.8 mm in diam., glabrous, style to 0.5 mm long, stigma minutely capitellate. Capsule globose, to 3.0 mm long, to 2.8 mm in diam., light brown, glabrous; seeds 2 per locule, rounded-triangular, gray or brown, testa reticulate-foveate (Fig. 61), hilum punctiform.

Distribution: known only from three collections at Lagoa Santa, Brazil.

SPECIMENS EXAMINED

Brazil. MINAS GERAIS: Lagoa Santa, 10 Mar. 1864, *Warming* 1070 (778) (C); Lagoa Santa, *Warming* (F, US p.p.).

I know this species from only three collections. According to the original description it was found in a wooded area above a rocky calcareous site near Lagoa Santa. Brazil and flowered from January to March.

The original description accords well with the type specimen. One discrepancy exists concerning the shorter stamens. The original description states: "Stamina tria interiora minora, . . ." In fact, the shorter stamens are opposite the sepals and are the outer whorl of stamens.

C. B. Clarke considered this species as part of his *Tradescantia elongata*. The habit and size of the plant.

shape of the laminar base, seeds, flower size and color, and stigma show this species to be distinct.

EXCLUDED SPECIES

Tripogandra cordifolia (Swartz) Aristeguieta, Bol. Acad. Ci. Fis. 25:125. 1965.

Tradescantia cordifolia Swartz, Nova genera & species plantarum seu prodromus . . . 57. 1788.

Leiandra cordifolia (Swartz) Rafinesque, Flora Telluriana 2:16. 1837 ('1836').

Callisia cordifolia (Swartz) Anderson & Woodson, Contr. Arnold Arbor. 9:117. 1935.

Phyodina cordifolia (Swartz) Rohweder, Abh. Auslandsk., Reihe C, Naturwiss. 18:151. 1956.

I have excluded *Tripogandra cordifolia* because it has six more or less similar, glabrous stamens. The genus *Phyodina* as interpreted by Rohweder is composed of diverse elements which show little affinity. This problem has been discussed to some extent by Moore (1963) but requires much more study in conjunction with a consideration of *Tradescantia gracilis*, *T. debilis*, and *Leptorhoeo filiformis*.

Tripogandra lundellii (Standley) Woodson, Ann. Missouri Bot. Gard. 29:153. 1942.

Tradescantia lundellii Standley, Publ. Field Mus. Nat. Hist. Bot. Ser. 22:5. 1940. TYPE: *Lundell* 7098 (Holotype F!; isotypes, MICH!, NY!).

Gibasis sp.

Standley's original description of *Tradescantia lundellii* described stamens of two lengths. This species cannot be considered one of *Tripogandra* because at anthesis the plants have six essentially similar stamens which are borne on flowers in a single cincinnus.

Tripogandra rosea (Ventenat) Woodson, Ann. Missouri Bot. Gard. 29:153. 1942.

Tradescantia rosea Ventenat, Jard. Cels 24. 1800. HOLOTYPE: *Michaux* P; photograph, GH!.

Cuthbertia rosea (Ventenat) Small, Flora of the Southeastern United States 237. 1903.
Phyodina rosea (Ventenat) Rohweder, Abh. Auslandsk., Reihe C, Naturwiss. 18:151. 1956.

Tripogandra rosea lacks the dimorphic stamens which characterize *Tripogandra sensu stricto*. Rohweder's inclusion of this species in *Phyodina* should be investigated further.

Tripogandra stenophylla (Brandegee) Matuda, Anales Inst. Biol. Univ. Nac. México 26:369. 1956 ('1955').
Tradescantia stenophylla Brandegee, Univ. Calif. Publ. Bot. 3:377. 1909. TYPE: *Purpus* 3352 (Holotype, UC!; isotype, NY!).

Tripogandra stenophylla is properly placed in the genus *Tradescantia* because this plant has six similar stamens and two foliaceous bracts subtending the double cincinnus.

Tripogandra warscewicziana (Kunth & Bouche) Woodson, Ann. Missouri Bot. Gard. 29:154. 1942.
Tradescantia warszewicziana Kunth & Bouche, Ind. Sem. Hort. Berol. 11. 1847.
Spironema warszewiczianum (Kunth & Bouche) Brückner, Notizbl. Bot. Gart. Berlin-Dahlem 10:56. 1927.
Phyodina warscewicziana (Kunth & Bouche) Rohweder, Abh. Auslandsk., Reihe C, Naturwiss. 18:151. 1956.
Hadrodemas warszewicziana (Kunth & Bouche) Moore, Baileya 10:134. 1963 ('1962').

Tripogandra warscewicziana must be excluded because of its inflorescence structure and a lack of dimorphic stamens. Moore (1963) has more fully discussed the placement of this unusual species.

Descantaria laxiflora (Clarke) Brückner, Notizbl. Bot. Gart. Berlin-Dahlem 10:56. 1927.
Tradescantia laxiflora Clarke in DC, Monographiae Phanerogamarum 3:307. 1881. TYPE: *Andrieux* 51 (Holotype, K!; isotype, M!).
Gibasis sp.

This species has a single cincinnus so it cannot be considered a species of *Tripogandra*.

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BOTANY DEPARTMENT
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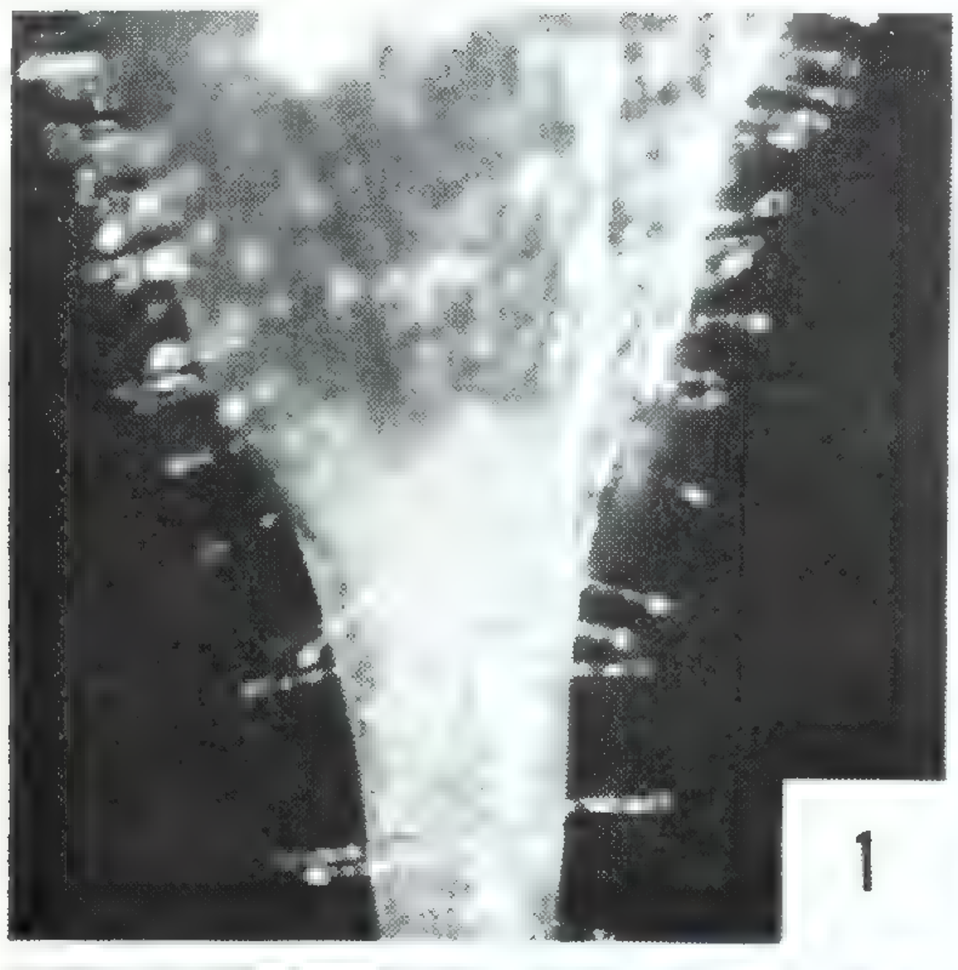
Fig. 1. Upper pedicel and lower calyx of *Tripogandra purpurascens* bearing capitate hairs. × 17.

Fig. 2. Upper pedicel and lower calyx of *T. saxicola* bearing uniseriate hairs. × 17.

Fig. 3. Upper pedicel and lower calyx of *T. serrulata*. × 17.

Fig. 4. Sheathing leaf base and node of *T. serrulata* showing a continuous line of uniseriate hairs on the sheath and internode. × 11.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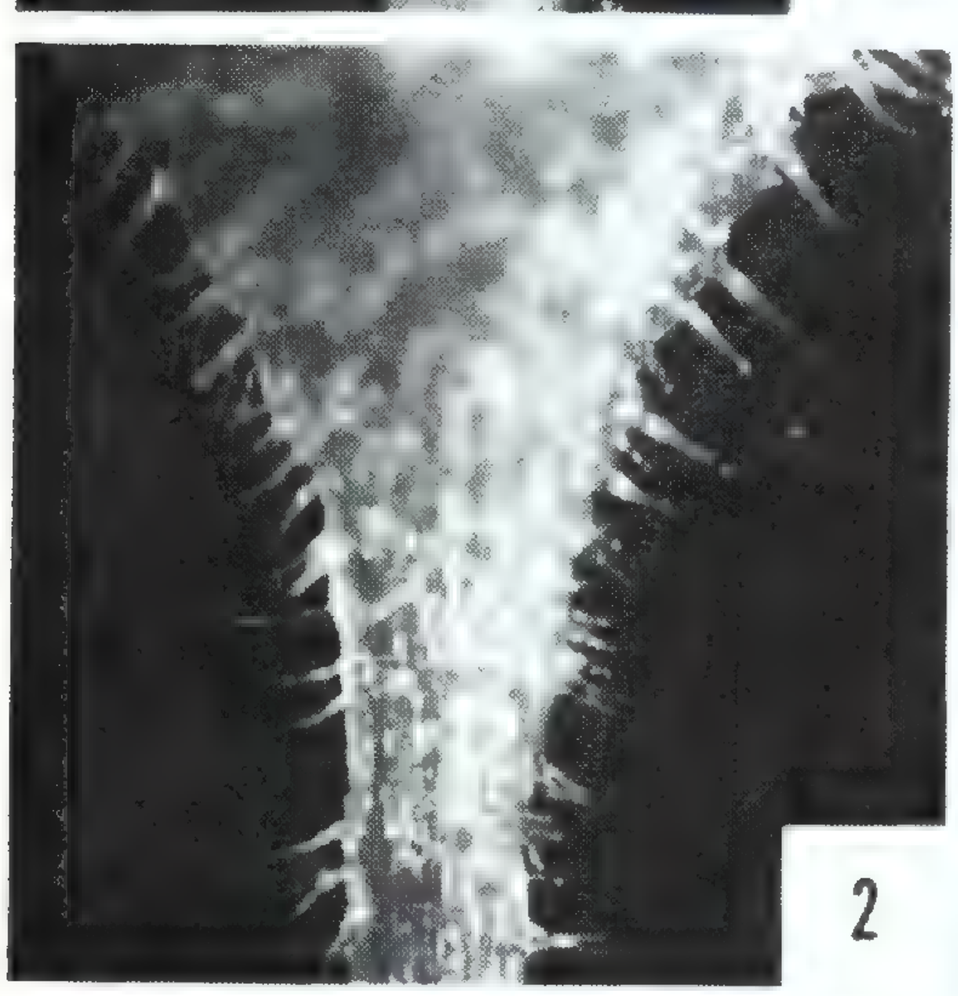
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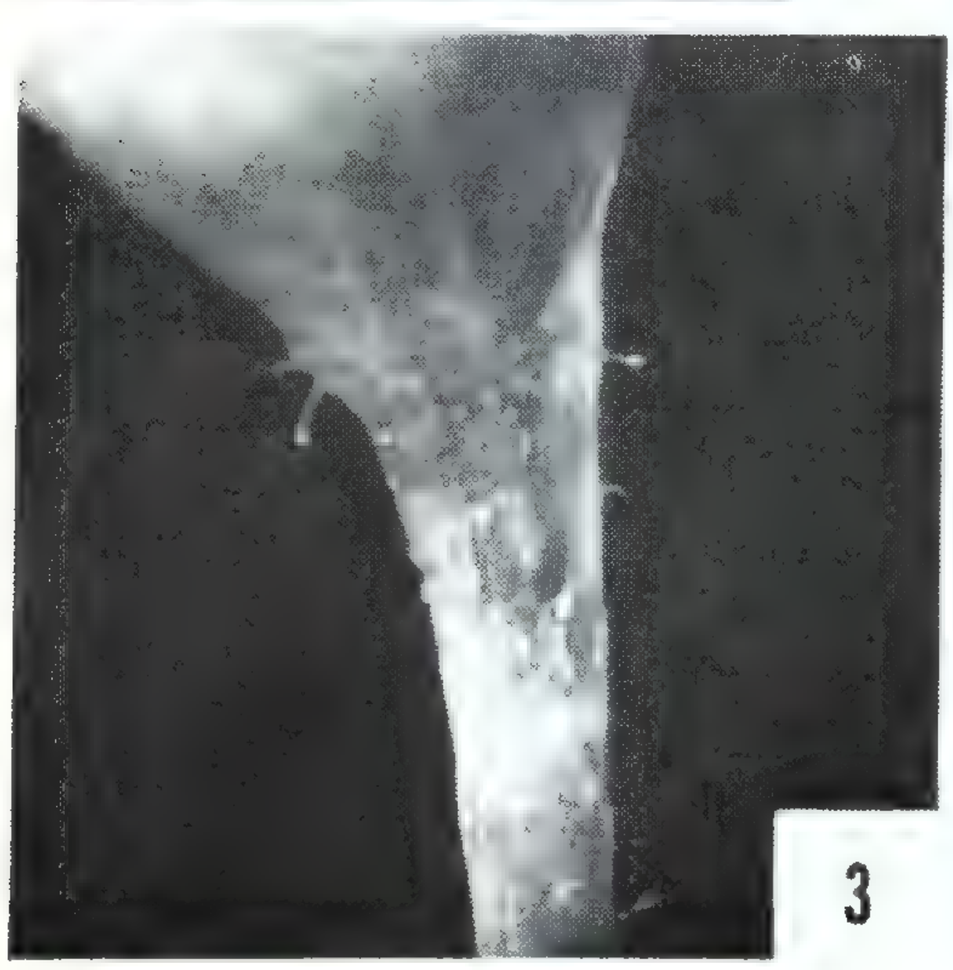
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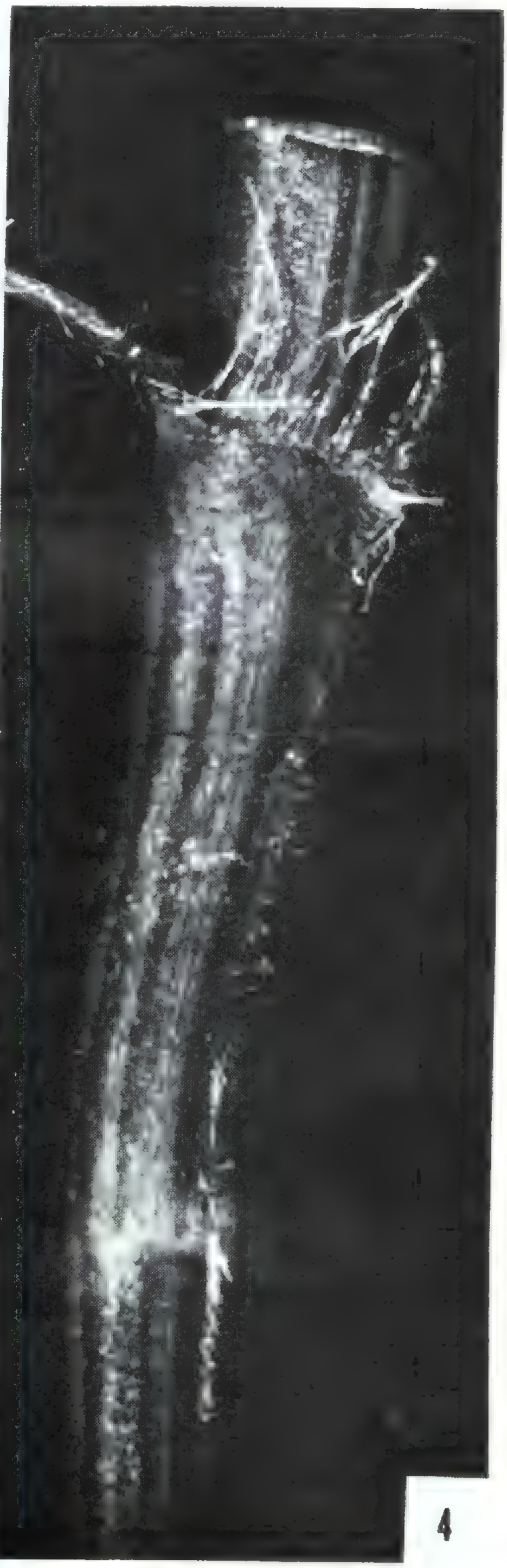
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Fig. 5. Outer stamen of *Tripogandra purpurascens*. × 11.
Fig. 6. Stamen of *T. amplexans*. × 11.
Fig. 7. Stamen of *T. amplexicaulis*. × 11.
Fig. 8. Stamen of *T. grandiflora*. × 11.
Fig. 9. Stamen of *T. grandiflora*. × 11.
Fig. 10. Outer stamen of *T. montana*. × 11.
Fig. 11. Stamen of *T. guerrerensis*. × 11.
Fig. 12. Outer stamen of *T. saxicola*. × 22.
Fig. 13. Stamen of *T. palmeri*. × 22.
Fig. 14. Stamen of *T. angustifolia*. × 22.

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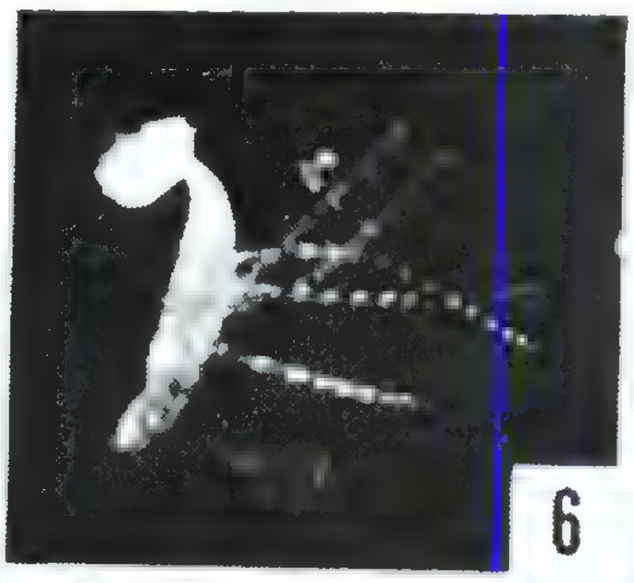
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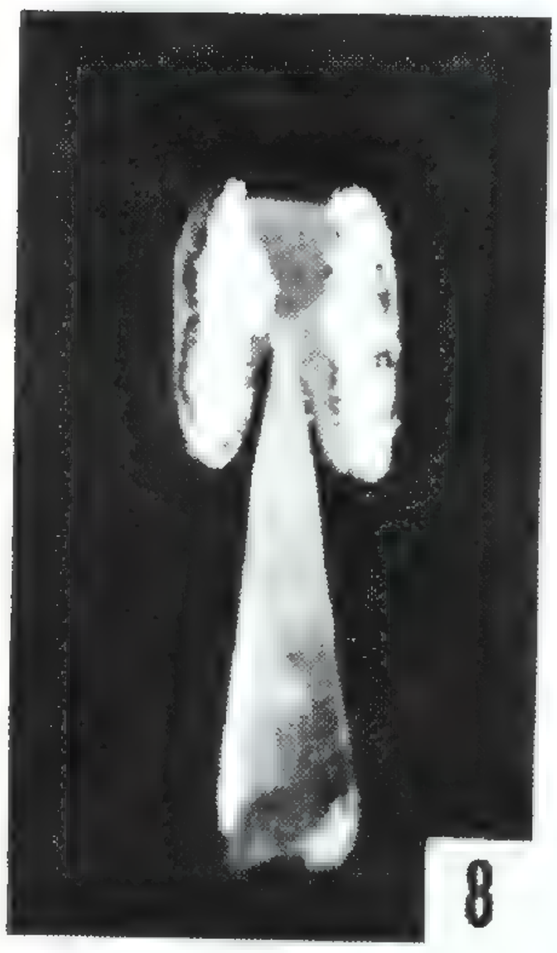
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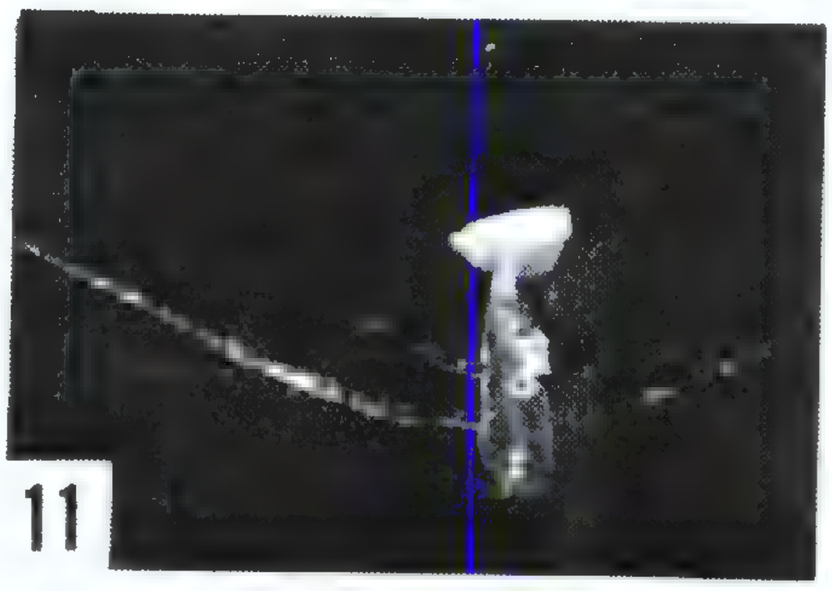
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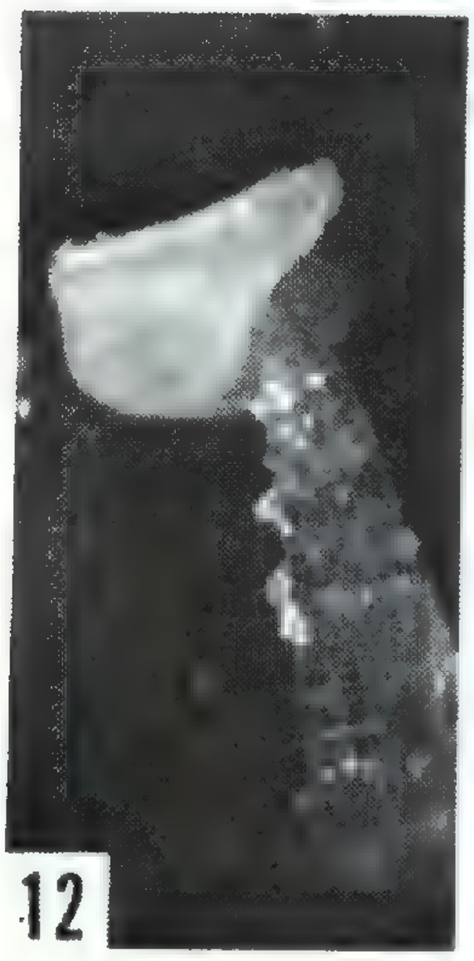
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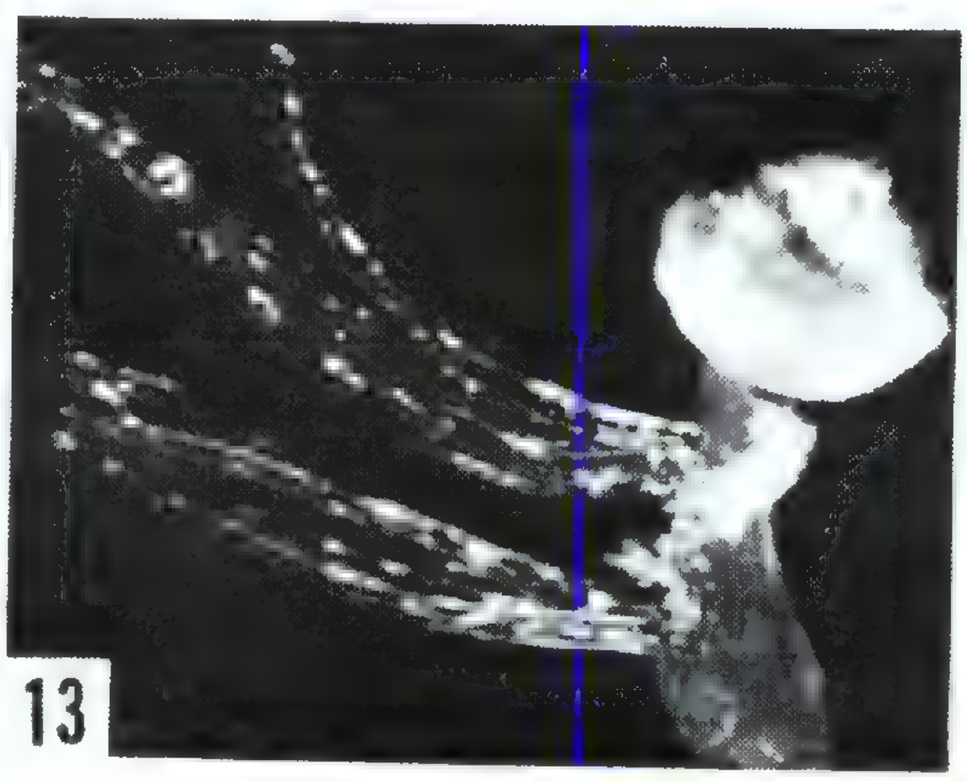
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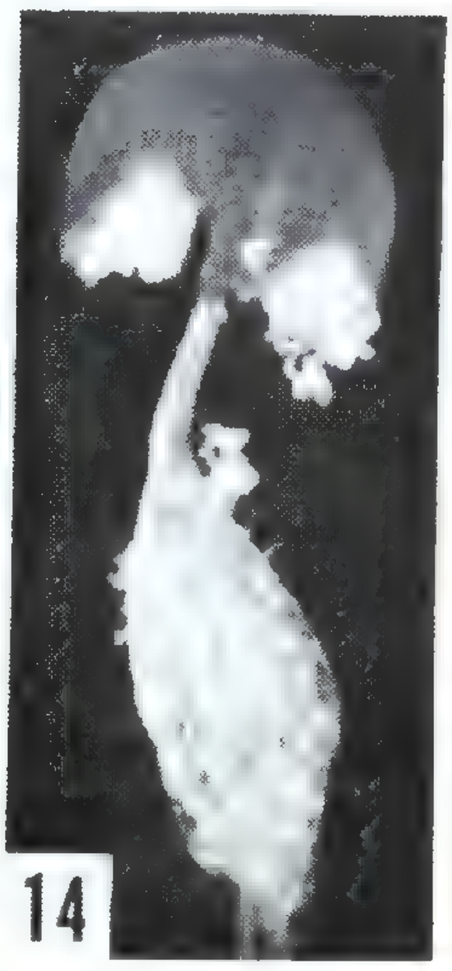
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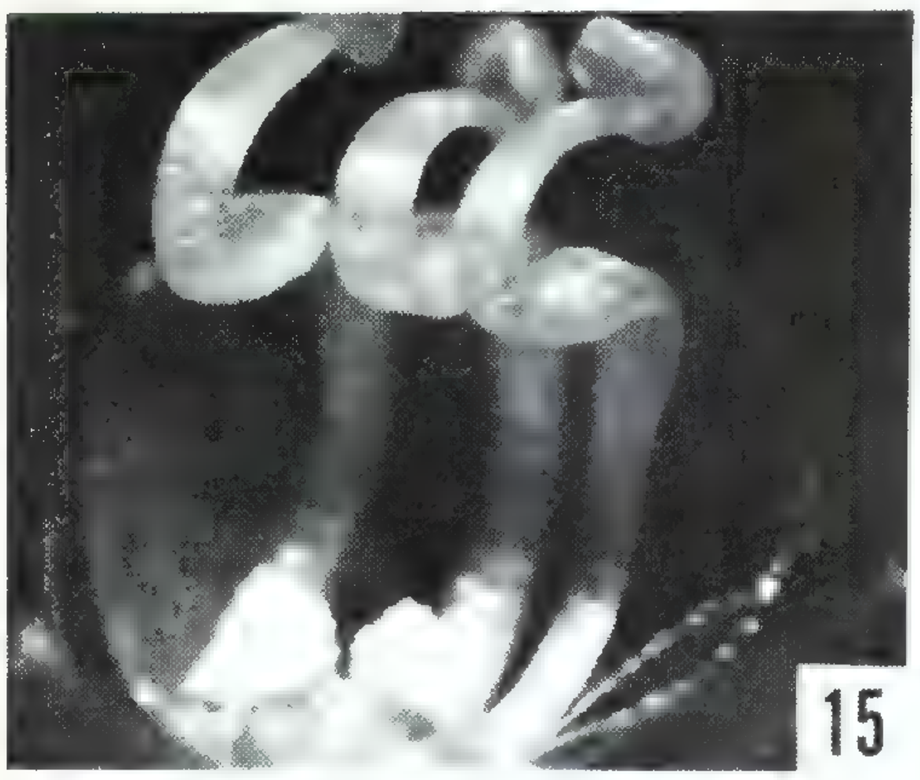
Fig. 15. Androecium of *Tripogandra guerrerensis*. × 11.
Fig. 16. Flower of *T. serrulata*. × 7.5.
Fig. 17. Staminode of *T. guerrerensis*. × 11.
Fig. 18. Inner stamen of *T. purpurascens*. × 11.
Fig. 19. Inner stamen of *T. serrulata*. × 11.
Fig. 20. Inner stamen of *T. saxicola*. × 11.
Fig. 21. Staminode of *T. palmeri*. × 11.
Fig. 22. Staminode of *T. palmeri*. × 11.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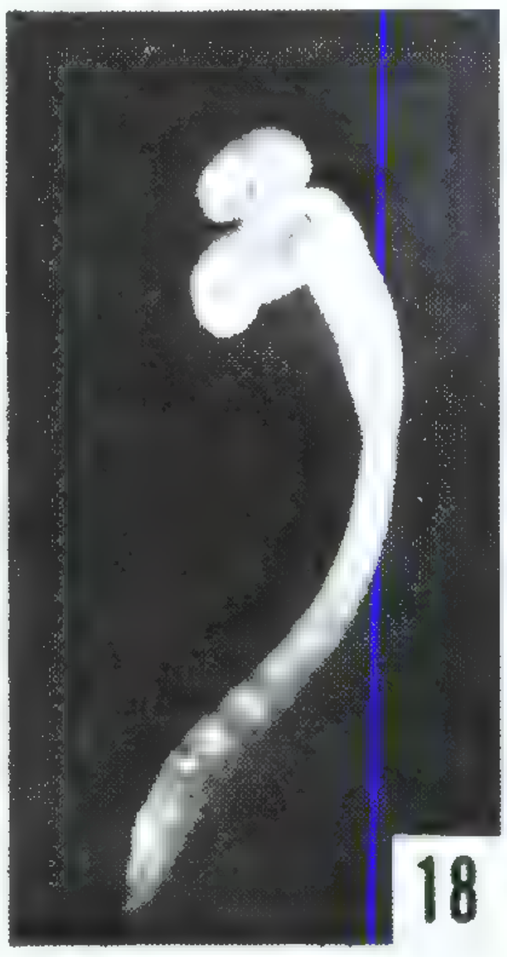
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Fig. 23. Distal portion of staminode of *Tripogandra amplexicaulis* showing the inflated filament. × 11.

Fig. 24. Germinating seed of *T. purpurascens* showing the emerging radicle and capping embryotega. × 34.5.

Fig. 25. Androecium and gynoecium of *T. amplexans* showing the relative positions of stamens and staminodes. × 11.

Fig. 26. Staminode of *T. amplexans*, lateral view. × 11.

Fig. 27. Distal portion of filament and anther of *T. angustifolia*. × 22.

Fig. 28. Distal portion of staminode of *T. grandiflora*. × 11.

Fig. 29. Staminode of *T. amplexicaulis*-*T. amplexans* intermediate. × 11.

Fig. 30. Staminode of *T. angustifolia*. × 16.

Fig. 31. Distal portion of inner stamen of *T. montana*. × 11.

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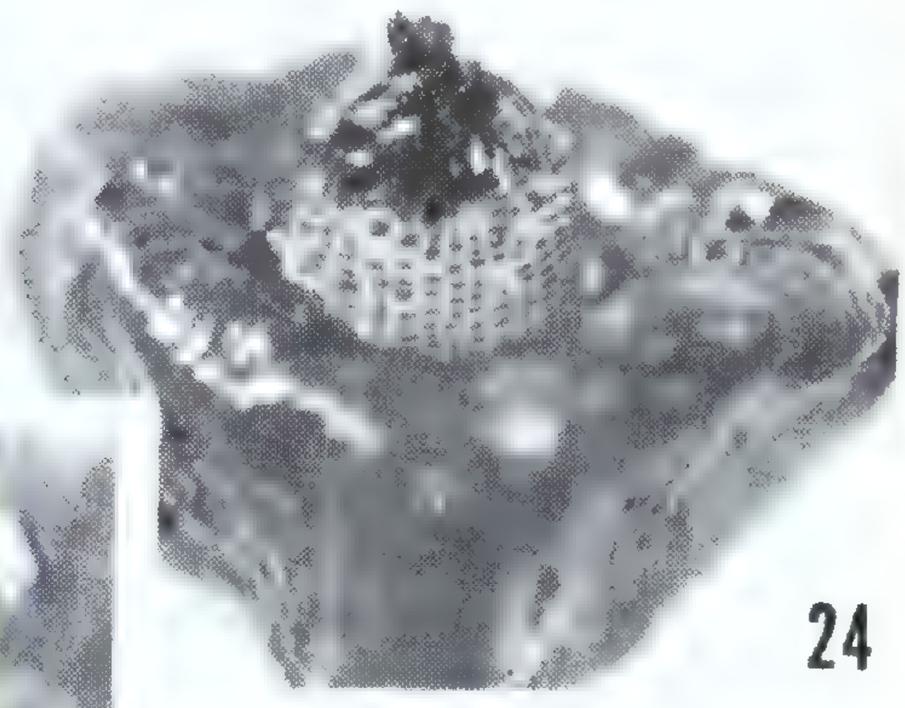
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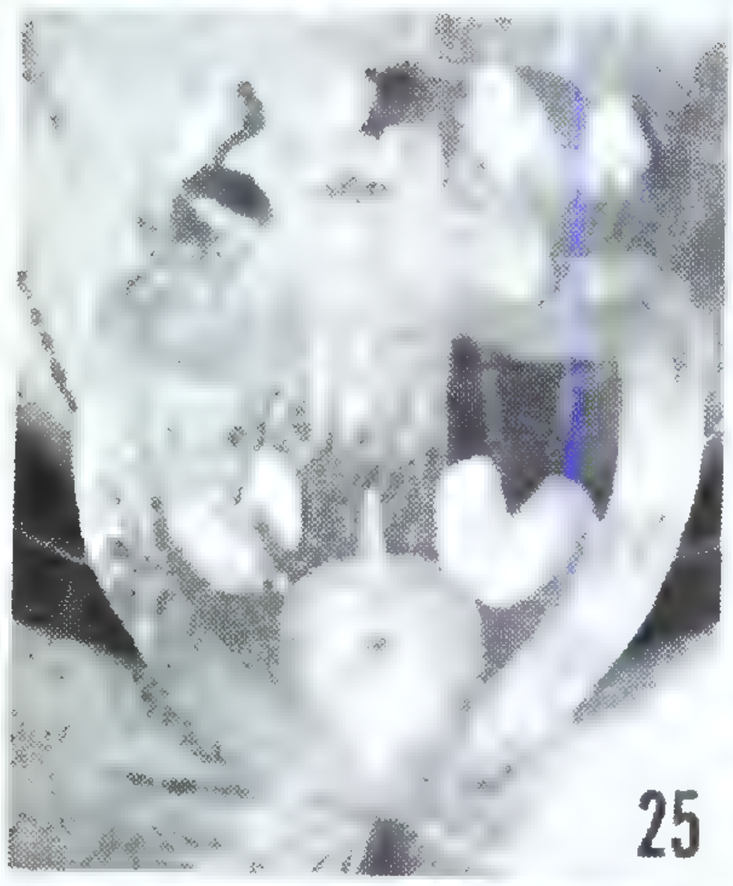
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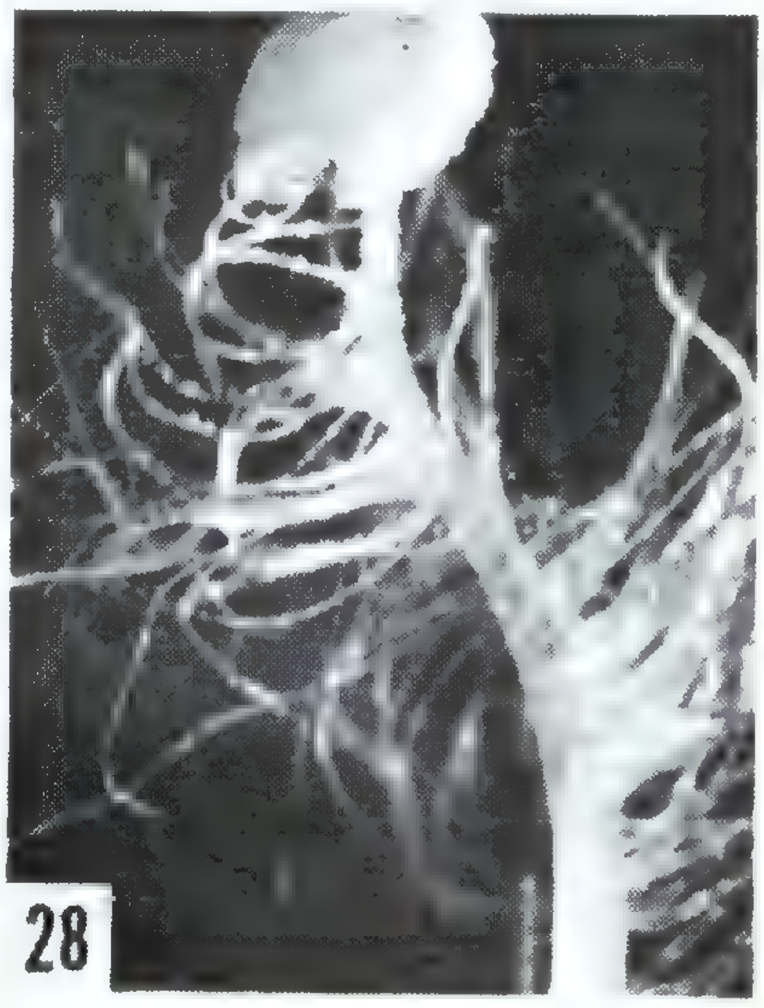
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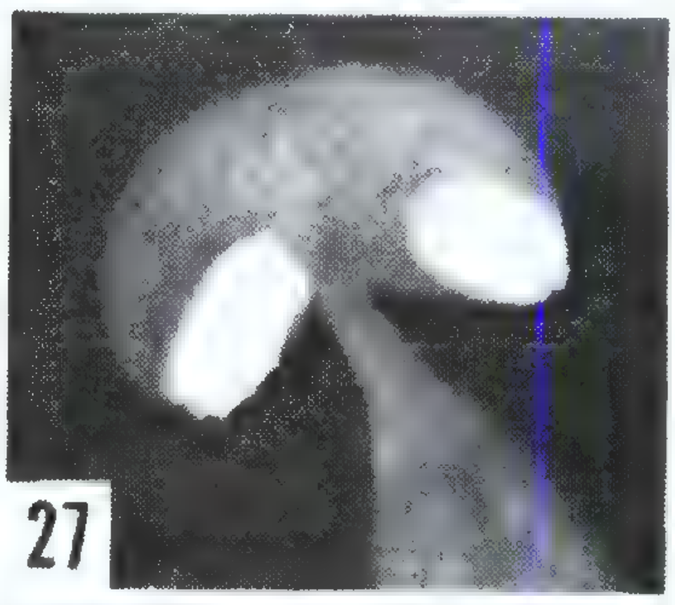
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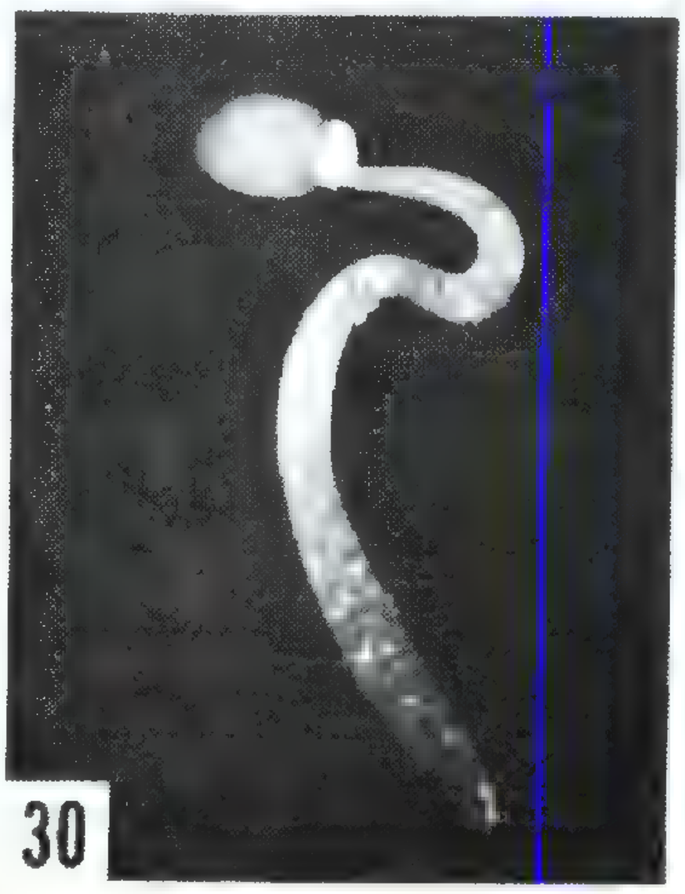
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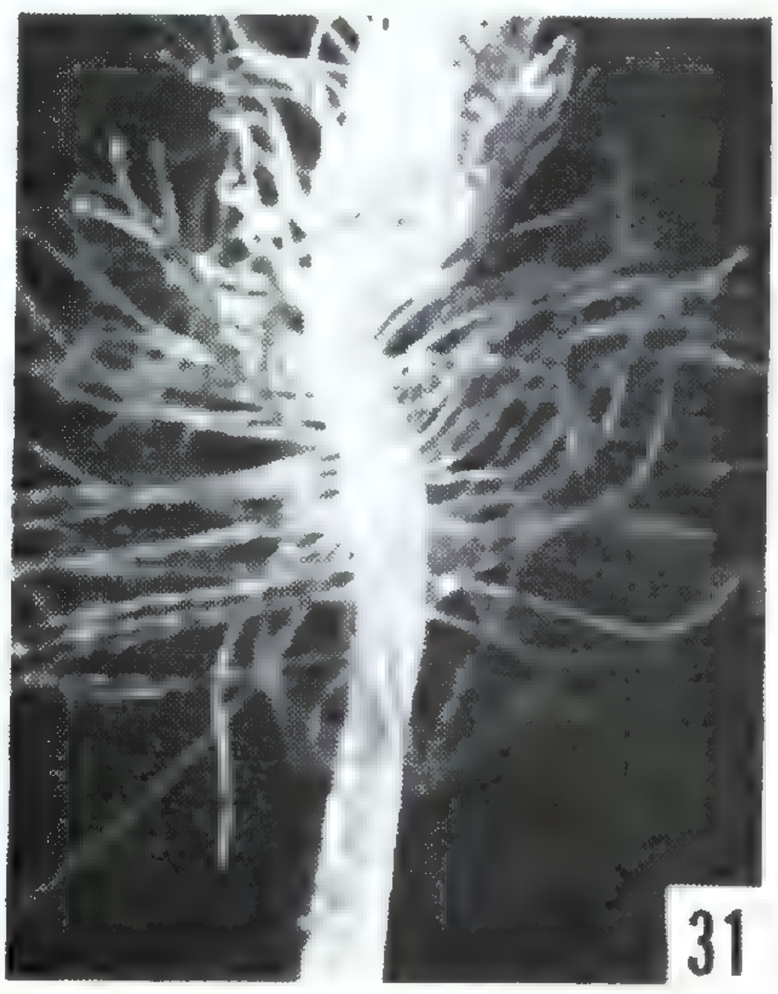
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Fig. 32. Seed of *Tripogandra multiflora*, dorsal surface.

Fig. 33. Seed of *T. multiflora*, ventral surface showing punctiform hilum.

Fig. 34. Seed of *T. multiflora*, dorsal surface.

Fig. 35. Seed of *T. multiflora*, ventral surface showing punctiform hilum.

Fig. 36. Seed of *Tradescantia triandra*, dorsal surface.

Fig. 37. Seed of *T. triandra*, ventral surface showing punctiform hilum.

Fig. 38. Seed of *Tripogandra serrulata*, dorsal surface.

Fig. 39. Seed of *T. serrulata*, ventral surface showing punctiform hilum.

Fig. 40. Seed of *T. diuretica*, dorsal surface.

Fig. 41. Seed of *T. diuretica*, ventral surface showing punctiform hilum.

Fig. 42. Seed of *T. glandulosa*, dorsal surface.

Fig. 43. Seed of *T. glandulosa*, ventral surface showing punctiform hilum.

Fig. 44. Seed of *T. montana*, dorsal surface.

Fig. 45. Seed of *T. montana*, ventral surface showing punctiform hilum.

Fig. 46. Seed of *T. montana*, lateral surface.

Fig. 47. Seed of *T. brasiliensis*, dorsal surface.

Fig. 48. Seed of *T. brasiliensis*, ventral surface showing elliptical hilum.

Fig. 49. Cleared ovary of *T. guerrerensis* showing two seeds, the upper larger and the lower smaller, and the dorsal bundle of one carpel.

The scale represents 1 mm.

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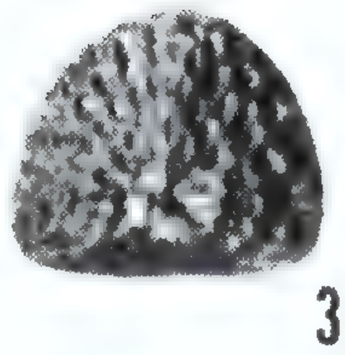
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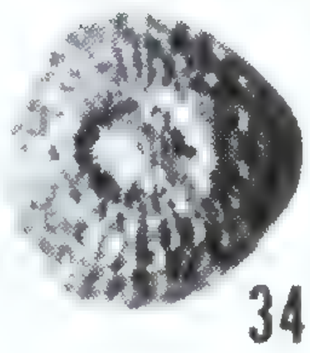
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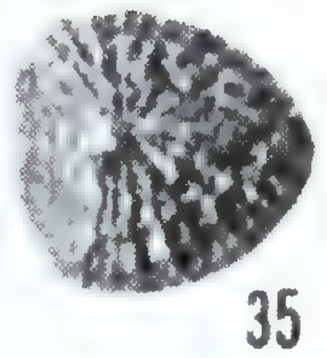
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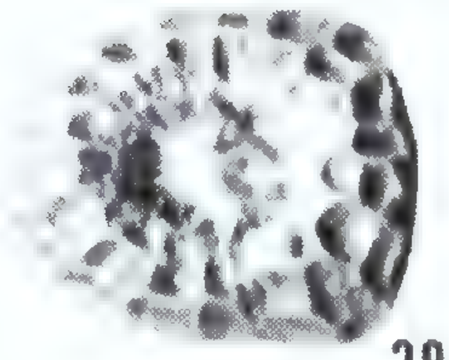
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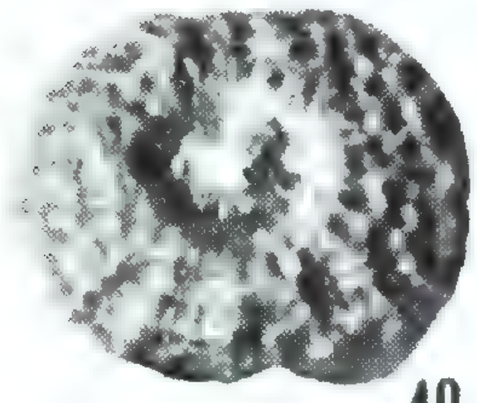
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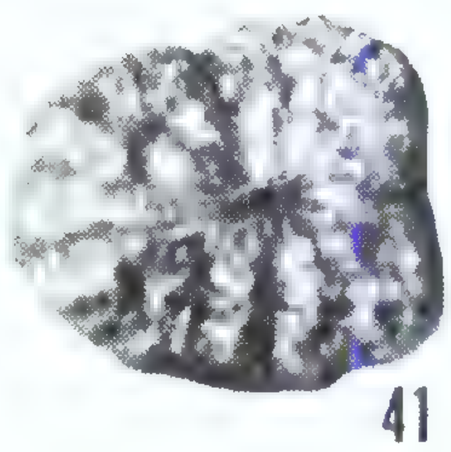
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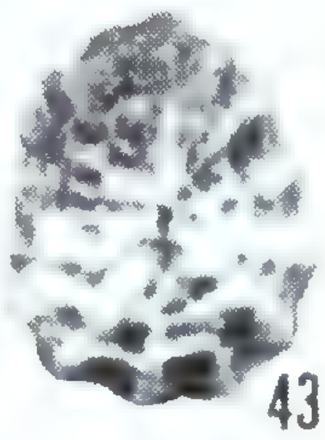
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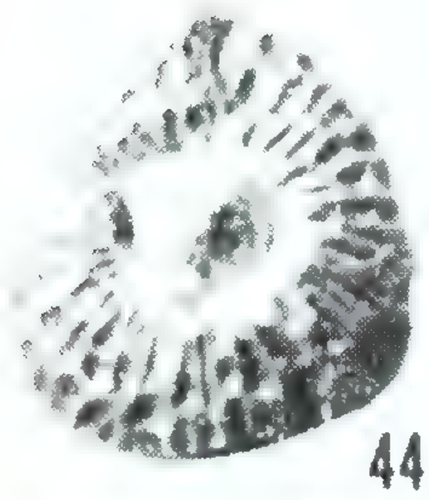
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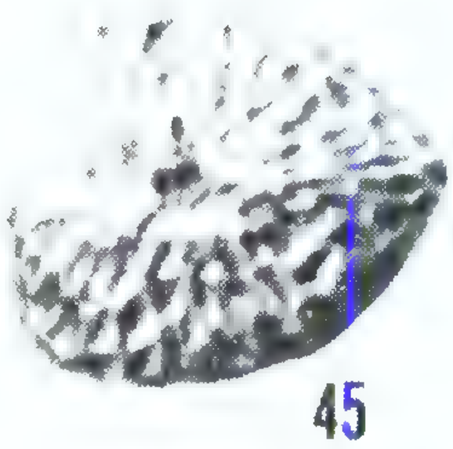
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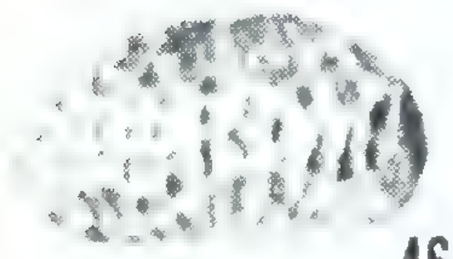
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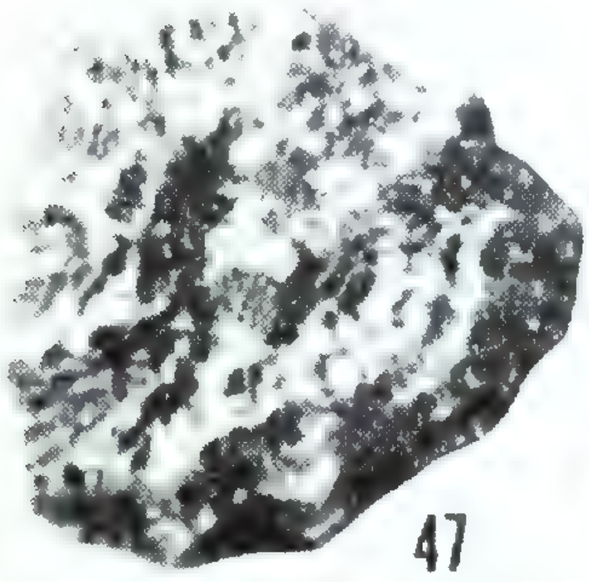
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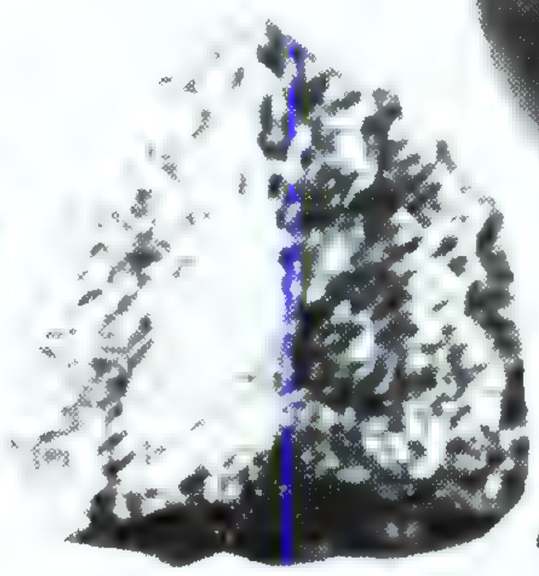
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Fig. 50. Seed of *Tripogandra purpurascens* subsp. *purpurascens*, dorsal surface.

Fig. 51. Seed of *T. purpurascens* subsp. *purpurascens*, ventral surface showing punctiform hilum.

Fig. 52. Seed of *T. disgrega*, dorsal surface.

Fig. 53. Seed of *T. disgrega*, ventral suface showing punctiform hilum.

Fig. 54. Seed of *T. purpurascens* subsp. *australis*, dorsal surface.

Fig. 55. Seed of *T. purpurascens* subsp. *australis*, ventral surface showing punctiform hilum.

Fig. 56. Seed of *T. saxicola*, dorsal surface.

Fig. 57. Seed of *T. saxicola*, ventral surface showing punctiform hilum.

Fig. 58. Seed of *T. amplexans*, dorsal surface.

Fig. 59. Seed of *T. amplexans*, dorsal surface.

Fig. 60. Seed of *T. amplexans*, ventral surface showing linear hilum.

Fig. 61. Seed of *T. warmingiana*, dorsal surface.

Fig. 62. Seed of *T. amplexicaulis-T. amplexans* intermediate, dorsal surface.

Fig. 63. Seed of *T. amplexicaulis-T. amplexans* intermediate, ventral surface.

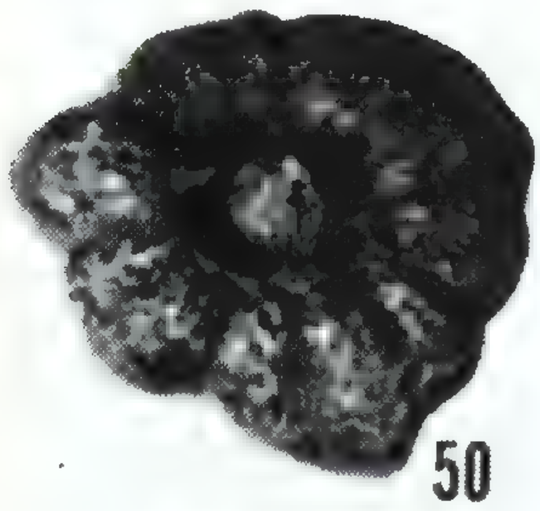
Fig. 64. Seed of *T. amplexicaulis*, dorsal side showing alveolate surface.

Fig. 65. Seed of *T. amplexicaulis*, ventral side showing linear hilum and alveolate surface.

Fig. 66. Seed of *T. amplexicaulis*, dorsal surface.

Fig. 67. Seed of *T. amplexicaulis*, ventral surface showing linear hilum.

The scale represents 1 mm.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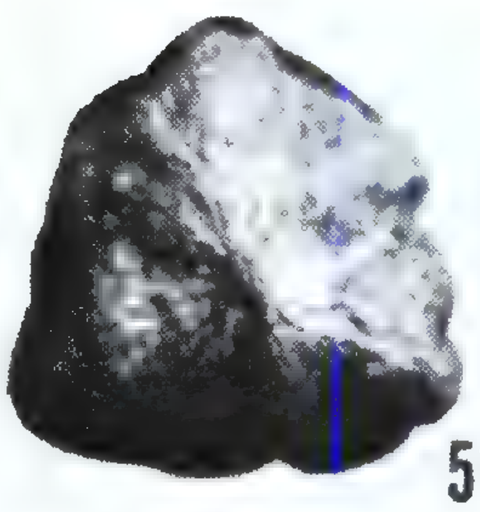
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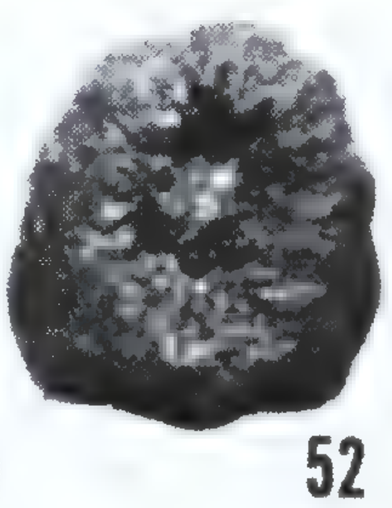
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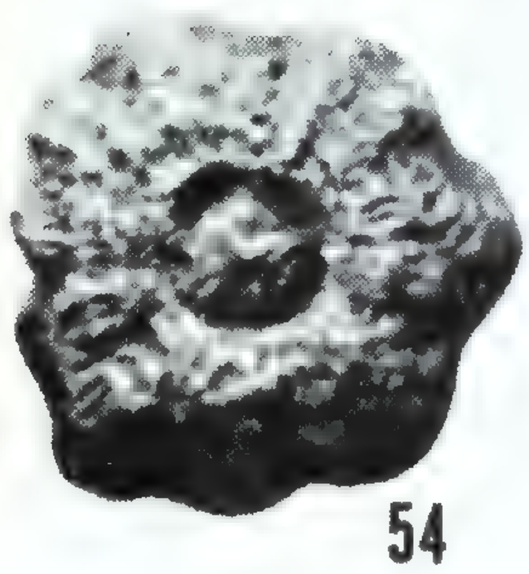
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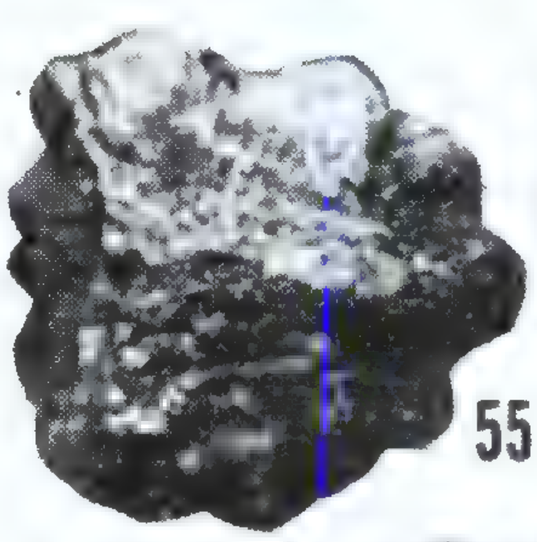
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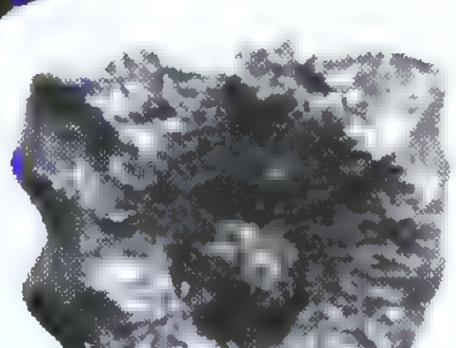
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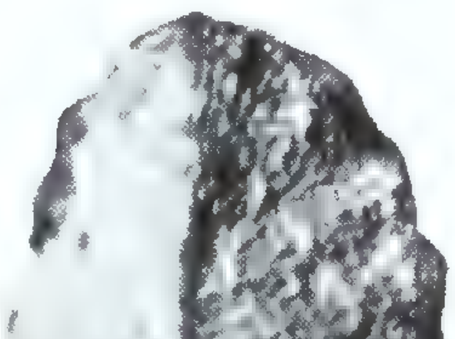
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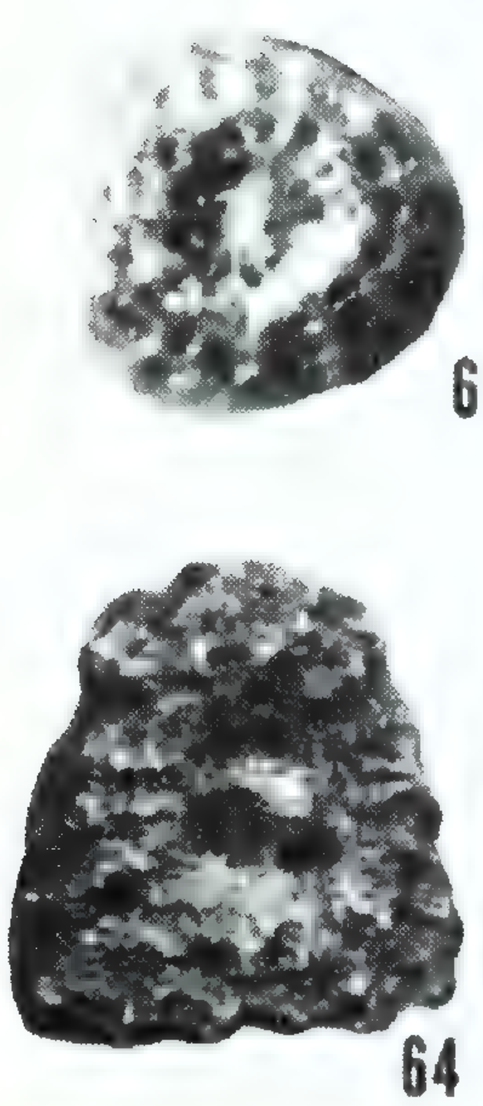
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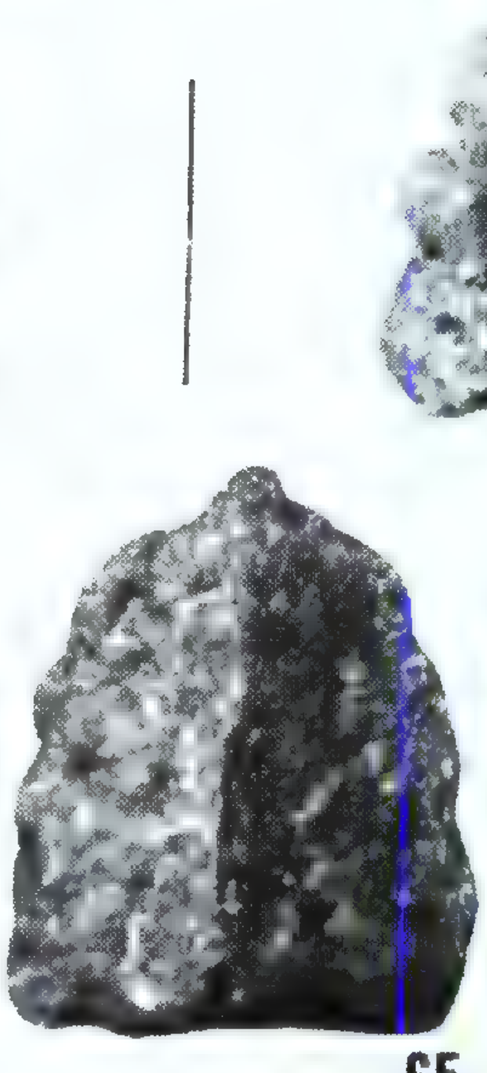
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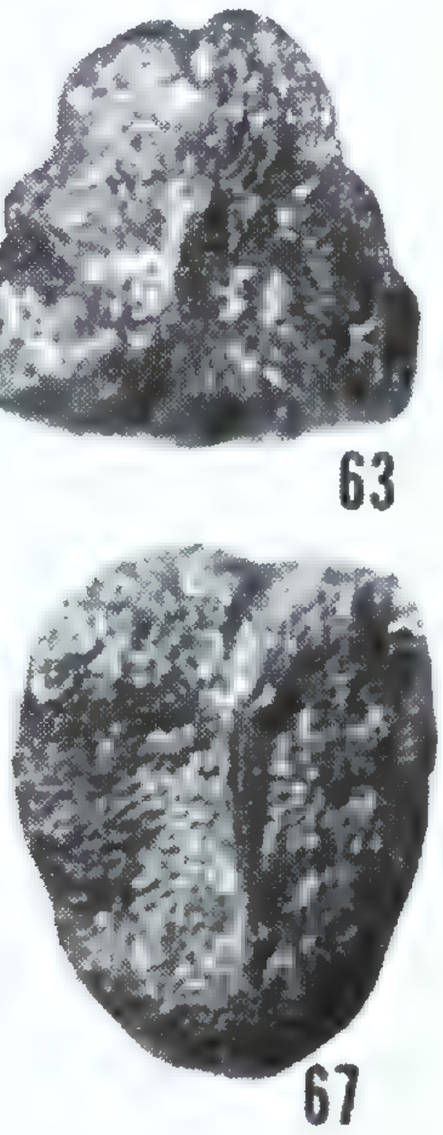
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Fig. 68. Seed of *Tripogandra guerrerensis*, dorsal surface, lower seed of the locule.

Fig. 69. Seed of *T. guerrerensis*, ventral surface showing elliptical hilum, lower seed of the locule.

Fig. 70. Seed of *T. guerrerensis*, dorsal surface, upper seed of the locule.

Fig. 71. Seed of *T. guerrerensis*, ventral surface showing elliptical hilum, upper seed of the locule.

Fig. 72. Seed of *T. palmeri*, dorsal surface.

Fig. 73. Seed of *T. palmeri*, ventral surface showing linear hilum.

Fig. 74. Seed of *T. angustifolia*, dorsal surface.

Fig. 75. Seed of *T. angustifolia*, ventral surface showing punctiform hilum.

Fig. 76. Seed of *T. grandiflora*, dorsal surface.

Fig. 77. Seed of *T. grandiflora*, dorsal surface.

Fig. 78. Seed of *T. grandiflora*, ventral surface showing linear hilum.

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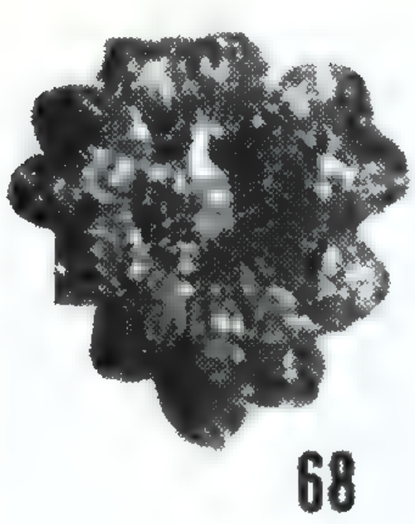

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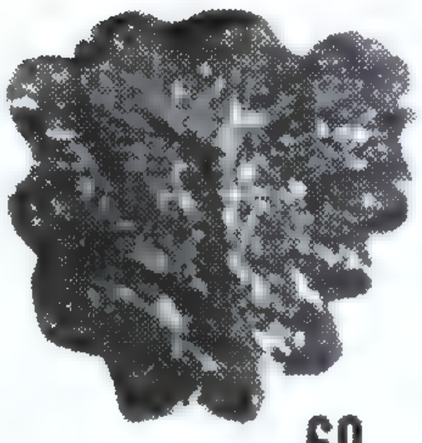

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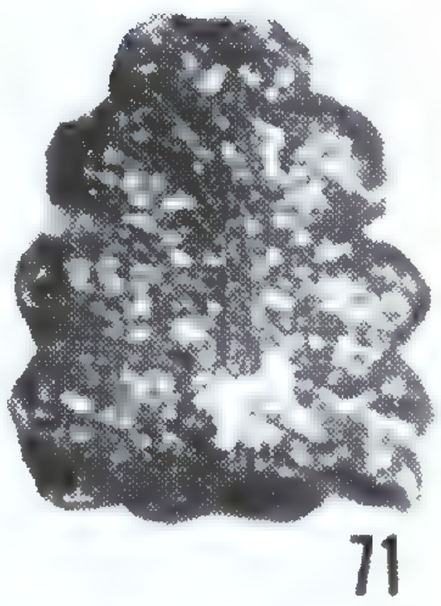

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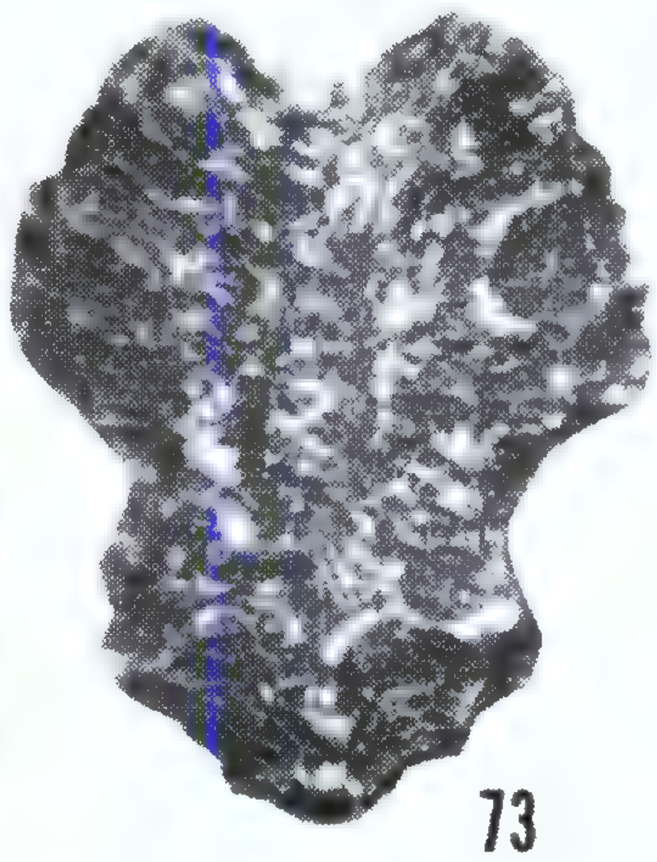

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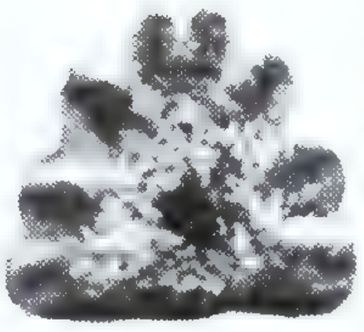

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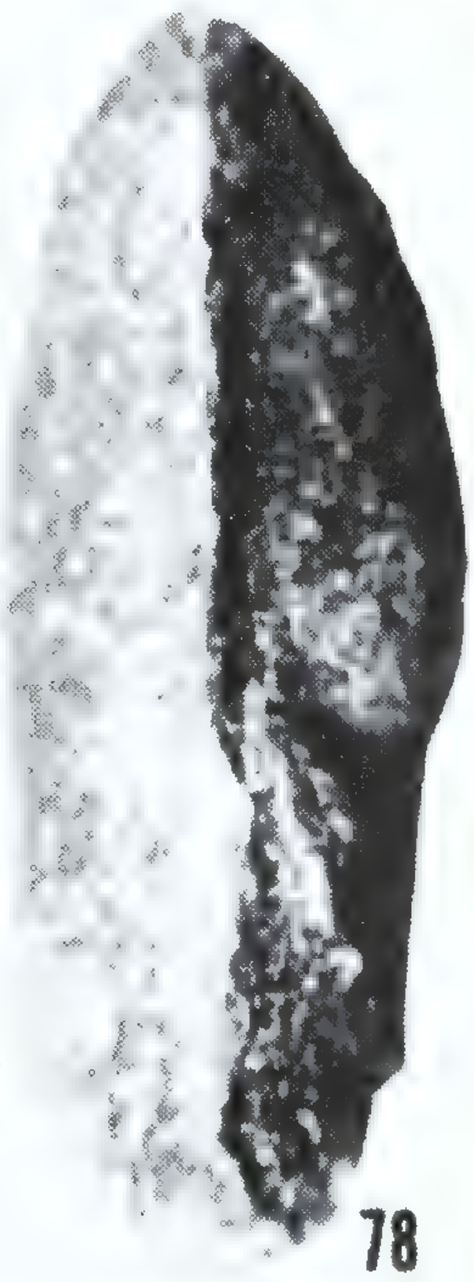

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THE FLORA OF CONCORD[1]: A REVIEW

The greater Boston area has a long history of botanical publications, beginning with Bigelow's *Florula Bostoniensis* of 1814. A "Flora of Middlesex County" by L. L. Dame and F. S. Collins was published in 1888. R. J. Eaton's *Flora of Concord* is in this tradition. Based on his own knowledge, the herbarium of the New England Botanical Club and the Gray Herbarium — which holds the most of Thoreau's herbarium — he has synthesized an annotated catalog which is both ecological and historical.

The Flora of Concord has been a labor of love. It is fortunate that the Museum of Comparative Zoology of Harvard University, having a Field Station in Concord, should have undertaken the publication of so useful a book. One hopes that this will stimulate the production of other local floras which are, after all, the stuff on which more synoptic works must eventually be based.

GORDON P. DE WOLF, JR.
ARNOLD ARBORETUM
JAMAICA PLAIN, MASS. 02130

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[1]Eaton, R. J. — A Flora of Concord; from Thoreau's Time to the Present Day. Cambridge, Mass.: Museum of Comparative Zoology: 1974.

REPORT ON ENDANGERED AND THREATENED PLANT SPECIES OF THE UNITED STATES

The Smithsonian Institution's *Report on Endangered and Threatened Plant Species of the United States* has been presented to Congress and published by the Government Printing Office. Contained in the 200-page Report are lists of endangered, threatened, commercially exploited and recently extinct species of the United States (including Alaska and Hawaii), as well as recommendations for the preservation and protection of these species. Listings of endangered and threatened species arranged alphabetically by States are included. A limited number of complimentary copies of the Report are available, upon written request, from: Endangered Flora Project, Department of Botany, Smithsonian Institution, Washington, D. C. 20560.

EDWARD S. AYENSU
DEPARTMENT OF BOTANY
SMITHSONIAN INSTITUTION
WASHINGTON, D. C. 20560

APPEAL FOR SUPPORT FOR THE INDEX HOLMENSIS PROJECT

The INDEX HOLMENSIS is an index of plant distribution maps with world-wide coverage. It is the only international bibliography on distribution of vascular plants in area and vegetation maps.

We have so far published four volumes, i.e. volume I, covering vascular cryptogams and gymnosperms, volume II containing *Monocotyledoneae* A-I, volume III *Monocotyledoneae* J-Z, and finally volume IV covering *Dicotyledoneae* A-B, together more than 1000 pages. We intend to continue to publish one volume each year. The total number of distribution maps so far published is estimated at about 400,000, all of which will finally be listed in the index or its supplement. Although the main work is at present done at the Swedish Museum of Natural History in Stockholm, the indexing work is served by an international editorial board. Members of this board to some extent guarantee completeness of the file for their particular area.

Still, the number of area and vegetation maps published annually is growing rapidly owing to the increased importance that is felt for the geographic compound of plant taxa. Consequently, not only are there wide areas all over the world where the entire flora is mapped systematically, but mapping has become a common feature in monographs in different fields, as for instance economic botany, palaeobotany, vegetational history, palynology, and last but not least phytocoenology.

In order to keep the file for the INDEX HOLMENSIS and its planned supplement volumes up-to-date we herewith ask our fellow botanists to inform us about their published maps and/or to send reprints of their publications. Needless to say, we shall also continue to supply all information on distribution maps so far not published in the INDEX HOLMENSIS to colleagues on request.

All correspondence should be addressed to: Hans Tralau, The Swedish Museum of Natural History, S — 104 05 Stockholm 50.

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Cover illustration

Rhododendron canadense (L.) Torr.

from

Curtis' Botanical Magazine t.474

RHODORA June, 1975 Vol. 77, No. 810

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Rhodora

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NEW ENGLAND BOTANICAL CLUB

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JOURNAL OF THE
NEW ENGLAND BOTANICAL CLUB

Vol. 77 September, 1975 No. 811

A REVISION OF THE NORTH AMERICAN GENUS *AMORPHA* (LEGUMINOSAE-PSORALEAE)

ROBERT L. WILBUR[1]

Amorpha is a small North American genus of papilionate legumes belonging to the tribe Psoraleae. It has been the subject of several taxonomic revisions (Schneider, 1907; Rydberg, 1919; and Palmer, 1931) as well as numerous regional treatments and one might suppose that such attention would have resulted in a rather satisfactory taxonomic understanding at the present time. However, such a favorable supposition would be completely unjustified and my presentation below is offered as an alternative. Although it is the result of an intensive if somewhat sporadic study timewise for more than fifteen years and an examination of more than twelve thousand specimens, I am not so naive as to believe that my account of the genus presented below is the ultimate answer either. Naturally I hope that future studies will show that the revision presented here is a closer approximation of the biological reality than the earlier accounts, but I would be less than candid if I were not to admit that I have found the genus to be extremely difficult and not especially tractable to the usual investigatory procedures of a "non-experimental" taxonomist.

[1]Grateful acknowledgment is hereby made for support given by the National Science Foundation to this research under NSF Grants 5636 and GB-13815.

The difficulty encountered with *Amorpha* as with any taxonomically perplexing taxon is not that there is too much variability or too little but that the variability that seemed so discrete when a relatively small number of specimens was examined becomes ever so much more like a continuum when thousands of specimens are studied. Environmentally induced plasticity of at least certain members of the genus is sometimes spectacular, and it certainly would prove disconcerting to those who have recognized numerous taxa in what I refer to as the *fruticosa*-complex to see the number of specimens that clearly possess the characteristics of one "taxon" in the growth produced early in the season and that of another "species" or "variety" in the later growth. The extraordinary morphological diversity exhibited by certain species of *Amorpha*, due both to apparently great genetical flexibility (i.e. numerous biotypes) and environmental plasticity, has resulted in the recognition of numerous taxa. For example, Rydberg (1919) recognized 23 species while Palmer (1931) accepted 20 species, 11 additional varieties and 7 forms for a total of 38 named taxa. The treatment presented here recognizes 15 species (including one new species, *A. ouachitensis* Wilbur) and 3 additional varieties.

Any definitive statement concerning the interrelationships of the genus *Amorpha* with its tribal neighbors in the *Psoraleae* must await more complete understanding of those genera as well as of *Amorpha* itself. Morphologically *Amorpha* seemingly is most closely related to the ditypic *Parryella* T. & G. ex A. Gray of Arizona and New Mexico and to the more widespread but still western genus *Eysenhardtia* H.B.K., which ranges from central Texas west to California and south into Guatemala. *Parryella* differs principally from *Amorpha* in that it is without at least all outward evidence of petals while *Eysenhardtia* has all 5 petals. The fruits of all three genera are 1(2)-seeded but, although all are indehiscent, those of *Parryella* and *Amorpha* are far more similar in texture, shape, and all other respects. With the facts available to us at the present time,

future research may support the hypothesis that *Amorpha*, *Parryella*, and *Eysenhardtia* were derived from a common ancestral complex and that *Amorpha* and *Parryella* are more closely related to one another than either is to *Eysenhardtia*.

My gratitude to the curators of the herbaria listed below is far greater than is even usually the case in similar acknowledgments for they have been extremely tolerant in permitting me to keep loans for far longer than is customary and without their understanding the study could not have been completed.

A, ARIZ, CAS, COLO, CS, DES, DS, DUKE, F, FLAS, FSU, GA, GH, IA, ISC, JEPS, KANU, KSC, MICH, MINN, MO, NCU, NDA, ND-GREENE, NEB, NSC, NY, OKL, OKLA, PHIL, POM, RSA, SDC, SDU, SMU, TENN, TEX, UARK, UC, UMO, US, USF.

Amorpha L., Sp. Pl. 743. 1753; Gen. Pl. ed. 5. 319. 1754.

Bonfidia Necker, Elem. Bot. 3: 46. 1790. (Art. 20(2) of the I.C.B.N. clearly states that this is not to be regarded as a generic name.)

Suffrutescent low shrubs to large bushy-topped shrubs. Leaves odd-pinnately compound with setaceous to linear, caducous stipules and short- to long-petiolate; leaflets (7) 11-29(45), entire to crenulate, epunctate to very densely and conspicuously glandular punctate, petiolulate, stipellate on the upper side. Inflorescence a spike-like, terminal raceme or the racemes clustered and then appearing paniculate; flowers pedicellate from the axil of a setaceous to linear, caducous bract. Calyx persistent, obconic, funnelform or even shortly campanulate, almost imperceptibly to strongly 5-lobed. Corolla reduced to a single petal, the banner, and it erect, enveloping the internal floral series, clawed, obovate to obcordate, often eventually the apical lobes adaxially recurved, purple, blue, violet or white, entire to erose. Stamens 10, at least basally monadelphous and occasionally the staminal tube exserted beyond the calyx; the filaments distinct above and exserted beyond the calyx

and usually the petal; anthers versatile, small, oblong, longitudinally dehiscent. Ovary ovoid, slightly compressed, 2-ovulate; style slender, elongate, exserted beyond the calyx and often the petal; stigma terminal, capitate. Fruit a 1-seeded, indehiscent pod, ± oblique, straight to strongly curved, compressed, slightly to very noticeably longer than the calyx, eglandular to conspicuously punctate glandular; seeds ovoid to oblong, laterally compressed.

Typification: *Amorpha fruticosa* L.; the genus was comprised of only one species when originally established.

Distribution: a North American genus of about 15 species ranging from southern Canada south to southern Florida and west to California.

KEY TO THE SPECIES OF AMORPHA

1. Petioles and the rachises of leaves beset with spine-like glands; plants of Arizona, California and Baja California.
   2. Vexillum reddish-purple, claw indistinct but about 1 mm long; filaments 6-7 mm long, united for the basal 2-3.2 mm; fruit densely to moderately pilosulose throughout (except in one area north of San Francisco Bay); plants of Arizona and northern California south into northern Baja California. . . . . 1. *A. californica.*
   2. Vexillum white, claw 2-3 mm long; filaments 8-12 mm long, united for the basal 1-1.5 mm; fruit glabrous or sparingly pilosulose only near the apex; plants known only from the Sierra San Pedro Martir of northern Baja California. . . . . 2. *A. apiculata.*
1. Petioles and the rachises of leaves lacking spine-like glands.
   3. Shrubs usually less than 1 m tall; leaves shortly petiolate with the petiole typically shorter than the width of the lowest leaflet.

4. Midvein of the leaflets included or but barely exserted and then its tip distinctly swollen, or if noticeably exserted, then the tip of mucro conspicuously swollen; plants of the southeastern United States.
5. Calyx-tube densely puberulent, or, if not, at least the lobes externally sparsely puberulent; stem, rachises (of both leaf and inflorescence), and leaflets densely pubescent, or, if not, usually at least somewhat puberulent; leaflets entire or but inconspicuously crenulate; petiolules usually less than 1.5 mm long and densely to sparsely pubescent; ranging from North Carolina south into peninsular Florida. . . . . 3. *A. herbacea.*
5. Calyx-tube and usually the lobes glabrous; stem, rachises (of both leaf and inflorescence), and leaflets glabrous or but very sparsely puberulent or short-pubescent; leaflets usually conspicuously crenulate; petiolules usually more than 1.5 mm long and glabrous (or rarely very sparingly puberulent); known only from Dade County, Florida. . . . . 4. *A. crenulata.*

4. Midvein of the leaflets exserted into a slender mucro with a tapered tip; plants of the southeastern United States and much of the central part of the continent.
6. Adaxial calyx-lobes 0.4-0.8(1.3) mm long, the abaxial lobe (1)1.2-1.6(1.8) mm long; plants of the coastal plain of the southeastern United States (the Carolinas and Georgia). . . . . 5. *A. georgiana.*
6. Adaxial calyx-lobes (0.6)1-1.5(1.8) mm long, the abaxial lobe (1.2)1.5-2.2(2.5) mm long; plants of the central United States (southern Canada south into Texas and from Indiana west into New Mexico and Wyoming).

7. Foliage and/or calyces conspicuously pubescent to the unaided eye and often canescent. . . . . 6. *A. canescens.*

7. Foliage and calyces glabrous or nearly so, or at least not conspicuously pubescent to the unaided eye and never canescent.

8. Leaflets appearing epunctate or at least the punctate glands on the lower surface of the leaflets not discernible without magnification; racemes usually clustered and mostly in groups of 5-10. . . . . 6. *A. canescens.*

8. Leaflets conspicuously punctate and the glands readily visible without magnification; racemes solitary. . . . . 7. *A. nana.*

3. Shrubs usually more than (1)1.2 m tall; leaves with petioles longer than the width of the lowermost leaflet.

9. Calyx-lobes nearly obsolete, all less than 0.8 mm long and never narrowly acute. . . 8. *A. glabra.*

9. Calyx-lobes or at least some well developed and longer than 0.8 mm and some narrowly acute or acuminate.

10. Calyx-lobes from about half as long to as long as the calyx-tube, all acute or acuminate; the lateral lobes more than 1 mm long.

11. Secondary venation slightly to moderately elevated beneath but the leaflets never conspicuously reticulate; abaxial calyx-lobes (1.8)2.5-3.5 mm long; plants of the Carolinas, Georgia, and Alabama. . . . . 9. *A. schwerinii.*

11. Secondary venation conspicuously elevated beneath often to the 3rd and 4th degree of branching and thus forming a striking reticulum; abaxial calyx-lobes

(1.2)1.5-2.0 mm long; plants of Louisiana and eastern Texas. . . . . 10. *A. paniculata.*

10. Calyx-lobes or at least some of them less than half as long as the calyx-tube, at least the adaxial usually rounded; the lateral lobes less than 1 mm long.
    12. Foliage, calyces and pedicels blackening or at least darkening upon drying; calyx-tube eglandular to sparingly glandular with very small and inconspicuous, slightly elevated punctate glands. . . . . 11. *A. nitens.*
    12. Foliage, calyces and pedicels never blackening and rarely even darkening upon drying; calyx-tube usually glandular with often large, conspicuous, elevated punctate glands.
        13. Petiolules conspicuously pustulate-glandular; leaflets typically emarginate and often with a globose tip to the midvein; plants of Texas or Oklahoma and/or Arkansas.
            14. Petals present on specimen.
                15. Petals bright blue to deep violet; stipules glabrous; plants of eastern Texas and Oklahoma. . . . . 12. *A. laevigata.*
                15. Petals purplish; plants of central Texas; stipules pubescent; eastern Oklahoma and/or west central Arkansas.
                    16. Abaxial calyx-lobes (0.8)1.0-1.2(1.4) mm long; central Texas on the Edwards Pla-

teau. . . . . .
. . 13. *A. roemeriana.*

16. Abaxial calyx-lobes about 0.6-0.9(1.2) mm long; Ouachita Mts. of southeastern Oklahoma and west central Arkansas. . . . 14. *A. ouachitensis.*

14. Petals lacking on specimen.

17. Calyx-tube beset with large conspicuous pustulate glands throughout the upper 1/2-2/3 its length, glabrous; eastern Texas and southeastern Oklahoma. . . . . 12. *A. laevigata.*

17. Calyx-tube sparingly to moderately supplied with often inconspicuous pustulate glands in the upper third of its length; glabrous to moderately spreading to appressed short-pubescent; central Texas or the Ouachita Mts. of southeastern Oklahoma and west central Arkansas.

18. Abaxial calyx-lobes (0.8)1.0-1.2(1.4) mm long; fruit about 6-7 mm long and 2.5-3.5 mm wide; central Texas on the Edwards Plateau. . . . . 13. *A. roemeriana.*

18. Abaxial calyx-lobes 0.6-0.9(1.2) mm long; fruit about 7-9 mm long and 3-4 mm wide; Ouachita Mts. of southeastern Oklahoma and west central Arkansas. ..... . 14. *A. ouachitensis.*

13. Petiolules eglandular or with only inconspicuous glands; leaflets acute to broadly rounded, only rarely emarginate and the midvein only rarely terminating in a globose or swollen tip; plants of almost the entire range of the genus. .... 15. *A. fruticosa.*

1. **Amorpha californica** Nutt. in Torr. & Gray, Fl. N. Am. **1**: 306. 1838.

Erect, bushy shrub (0.7)1-3(4) m tall. Current season's growth sparingly to more typically moderately puberulent or crinkly-pilosulose bearing few to numerous, usually conspicuous, often apically pointed or sharply hooked, as well as basally swollen, resiniferous, amber-colored glands. Leaves ascendant to spreading, (0.5)1-1.5(2.0) dm long. Petioles (0.7)1-1.5(2.5) cm long, usually equaling or longer than the width of the lowermost leaflet, densely crinkly-pilosulose or puberulent to glabrous with several to numerous, rounded and pointed, resiniferous, pustulate glands. Stipules caducous, oblong-lanceolate to lanceolate or linear, eglandular, reddish-brown, sparingly to densely, appressed tawny-pilosulose, (2)4-6 mm long. Rachis of leaf slender, about 1 mm in diameter, densely crinkly-pilosulose or puberulent to glabrous, moderately beset with both sharp-pointed and rounded, amber-colored, resiniferous, sessile glands. Leaflets (11)13-19(25), oblong to elliptic-oblong, (0.8)1.5-2.5(4.2) cm long, (0.6)1-1.5(2.0) cm wide, typi-

cally 1.5-2.2 times as long as wide, opposite or more typically alternate, symmetrical, more or less broadly rounded to subcordate basally, typically broadly rounded to obtuse and emarginate apically, entire to inconspicuously crenulate; secondary veins very slightly, if at all, elevated beneath. Midvein usually terminating in a swollen, globose tip flush with the margin or very rarely slightly exserted or very rarely somewhat tapering. Lower surface of leaflets moderately pilosulose throughout but densely so along the midvein to glabrous or very nearly so, conspicuously glandular-punctate below with light to dark brown, resinous glands of apparently 2 sizes; upper surface typically moderately pilosulose but occasionally glabrous, eglandular. Petiolule 0.7-1.5(1.8) mm long, densely spreading pilosulose to glabrous, sparingly to moderately pustulate-glandular. Racemes erect, usually solitary but rarely few together, (0.5)1-1.8(2.5) dm long; rachis of inflorescence moderately spreading-pilosulose, hirsutulous or puberulent to glabrous, sparingly glandular pustulate with both rounded and sharp-pointed glands. Pedicels 0.3-1.2 mm long, densely spreading- to appressed-pilosulose hirsutulous or puberulent to glabrous, eglandular; bracts lanceolate to narrowly linear, 1.5-4 mm long, externally moderately spreading- to appressed-pilosulose, eglandular to moderately pustulate-glandular, internally glabrous, caducous. Calyx-tube narrowly cylindric or somewhat funnelform, 2.0-2.8 mm long, moderately spreading- to appressed-pilosulose or puberulent throughout to glabrous, abundantly to sparingly pustulate-glandular in upper half. Calyx-lobes usually tipped by a conspicuous pustulate gland and also frequently sparingly to moderately glandular-pustulate, densely to moderately pilosulose or glabrous both externally and internally. Adaxial calyx-lobes broadly to narrowly triangular-dentate, acute, (0.4)0.8-1.5(2) mm long; lateral calyx-lobes slightly longer, acute to acuminate, (0.5)1-2(2.2) mm long; abaxial lobe narrowly lanceolate, acuminate, (0.8)1.5-2.5 mm long. Vexillum 5-7 mm long, about 2.5-4 mm wide, broadly obovate, gradually tapering to the

short, indistinct claw about 1 mm long, moderately to strongly arching, apically more or less truncate to emarginate and often with a central apiculation, reddish-purple and with the claw and blade both strongly enveloping the filaments. Filaments 6-7 mm long, united into a sheath for the basal 2.0-3.2 mm, glabrous; anthers about 0.5-0.7 mm long, pale yellow. Style moderately ascending-pilose; ovary either densely pilosulose or very sparingly so and then only apically. Fruit 6-8 mm long, 2.5-3.5 mm wide, broadest above the middle, tapering somewhat basally, with the adaxial margin straight or slightly outwardly outcurved above and the abaxial strongly outwardly bowed, densely to moderately pilosulose throughout or only sparingly strigillose apically, pustulate-glandular in the upper half or two-thirds. Seeds smooth, plump, 2.5-3.2 mm long, light- to olive-brown.

Distribution: Northern California (approximately 41° N) south into the Sierra San Pedro Martir of northern Baja California (approximately 31° N) and sporadically eastward as far as southeastern Arizona.

Two rather strikingly distinct varieties have been recognized within this species. Their distribution as shown by our rather conventional but crude mapping does not suggest that they are strictly allopatric but a more refined appraisal of their relationship should wait at least careful field observations. The two may be separated by the following key.

A) Upper surface of leaflets, rachises and petiolules moderately to densely spreading-pilosulose or puberulent; calyx-tube moderately spreading-pilosulose or occasionally appressed-pilosulose; calyx-lobes all, or at least the longest, over 1 mm long. . . . . 1a. var. *californica*.

A) Upper surface of leaflets, rachises and petiolules glabrous or very nearly so; pubescence on lower surface of leaflet lacking or largely restricted to the midvein; calyx-tube glabrous or nearly so or sparingly to rarely

moderately strigillose; calyx-lobes all 1 mm long or less. ..... 1b. var. *napensis*.

1a. **A. californica** var. **californica**

Amorpha californica Nutt. in Torr. & Gray, Fl. N. Am. **1**: 306. 1838. TYPIFICATION: "St. Barbara, California, near the coast," *Nuttall* s.n. (holotype(?), NY!).

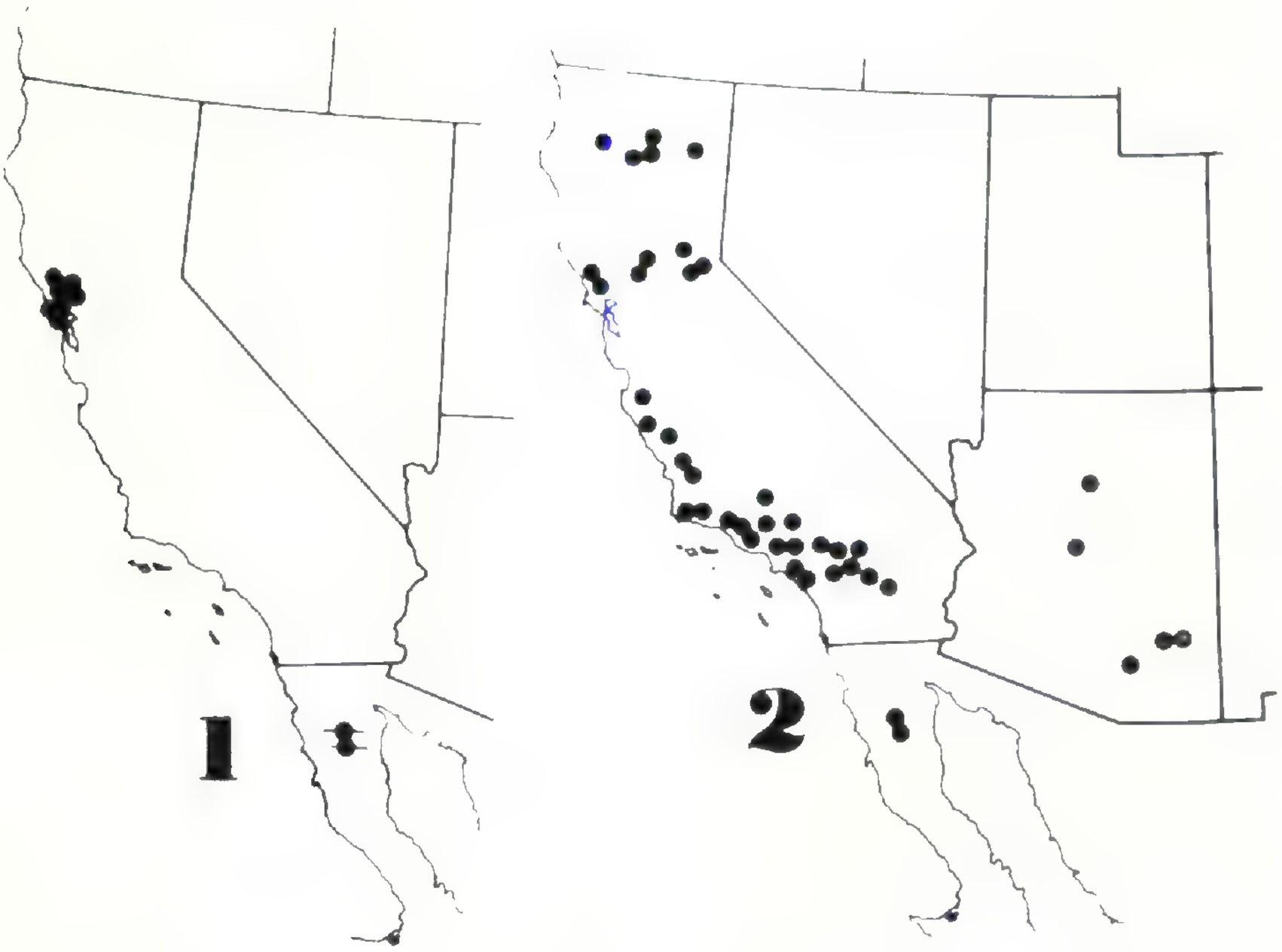
A. hispidula Greene, Fl. Fran. 14. 1891. TYPIFICATION: **California:** MONTEREY CO., *Hickman* s.n. (lectotype, ND-G!).

A. californica var. *hispidula* (Greene) Palmer, Jour. Arnold Arb. **12**: 163. 1931.

Branchlets, rachises, petioles and petiolules moderately spreading pilosulose or puberulent; leaflets spreading- to appressed-pilosulose above and below. Calyx-tube usually moderately to densely spreading- or appressed-pilosulose or puberulent, eglandular or sparingly and inconspicuously pustulate-glandular. Calyx-lobes usually more than 1 mm long. Pod moderately to densely more or less appressed, short-pubescent.

Distribution: Coastal Ranges north of San Francisco to about 38°30′ N and along the Coastal Ranges south of San Francisco from Monterey Co. (about 36°30′ N) into northern Baja California in the Sierra San Pedro Martir (about 30°30′ N); also in an area south of Mt. Shasta (about 41° N) and on the western slopes of the Sierra Nevada (about 39° N); disjunctly occurring in central and southeastern Arizona. (Map 2.)

1b. **A. californica** var. **napensis** Jepson, Man. Fl. Pl. Calif. 556. 1925. TYPIFICATION: **California:** Howell Mt., Napa Range, *Jepson* 6835 (lectotype, JEPS!). The lectotype, designated by Jepson (Fl. Calif. **2**: 331. 1936), is a sterile specimen and apparently a crown sprout while his number 6834 collected on the same day and the same place, is the fruiting specimen from which most of the diagnostic information was obtained.



MAPS 1-2. Map 1. *Amorpha californica* var. *napensis* (dots north of San Francisco Bay) and *A. apiculata* (dots with horizontal line in Baja California). Map 2. *A. californica* var. *californica*.

Branchlets, rachises, petioles and petiolules very sparingly pilosulose or more typically glabrous; leaflets glabrous above and either glabrous beneath or the pubescence primarily restricted to the midvein. Calyx-tube glabrous or sparingly strigillose above or rarely moderately strigillose throughout. Calyx-lobes usually all 1 mm long or less and ranging from 0.4-1.0 mm long. Fruit sparingly to moderately strigillose apically or throughout.

Distribution: endemic to the area north of San Francisco Bay in Marin, Napa and Sonoma Counties. (Map 1, in part.)

Both recent California floras (Munz, 1959, and Abrams, 1944) indicate the species is divisible into two varieties: a northern one ranging from the Shasta area of southern California south to Monterey and a southern variety ranging from the Santa Lucia Mountains just south of Monterey south to the Santa Ana and Santa Rosa Mountains

of extreme Southern California. The range of the varieties presented by these authors is in obvious conflict with those found in this study although the morphological features characterizing the taxa in all three studies seem to be identical.

2. **Amorpha apiculata** Wiggins, Contr. Dudley Herb. **1**: 171. 1933. TYPIFICATION: **Mexico:** banks of the Rio Santo Domingo about 5 miles above Mission Santo Domingo, Baja California, *Wiggins & Demaree* 4776 (holotype, DS, not seen; isotypes, ARIZ!, DS!; F!; NY!, POM!, RSA!).

Erect, slender shrub 2-5 m tall. Current season's growth moderately to sparsely spreading-pilosulose bearing few to numerous, rounded, resiniferous, amber-colored, elliptic glands and a few, apically pointed, basally rounded, spine-like glands. Leaves ascendant to spreading, 1-2 dm long. Petioles 1-2.5 cm long, usually equaling or longer than the width of the lowermost leaflet, sparingly to moderately spreading-pilosulose, with several to numerous, usually rounded but occasionally pointed, amber-colored glands. Stipules caducous to tardily deciduous, linear to linear-setaceous, glandular, sparingly pilosulose, 2-3 mm long. Rachis of leaf slender, about 1 mm in diameter, sparingly to moderately pilosulose, moderately beset with rounded or pointed, amber-colored, resiniferous, sessile glands. Leaflets (9)13-19(25), elliptic to oblong-elliptic, mostly 1.5-3.0(3.8) cm long and (0.5)1.0-1.5 cm wide, typically 2.2-3.3 times as long as wide, usually alternate and symmetrical, tapering either both basally and apically and often acute to more or less rounded; secondary veins very slightly elevated beneath. Midvein exserted, 0.2-0.8 mm long, slightly to conspicuously swollen at the tip. Lower surface sparsely pilosulose throughout or more or less restricted to the midvein where tending to be wide-spreading, "light green, slightly glaucous," conspicuously glandular-punctate below with dark, resinous glands of apparently 2 sizes; upper surface glabrous, "bright green," moderately to sparingly punctate-glandular. Petiolules 1.5-2.2 mm long,

sparingly to moderately spreading to somewhat appressed pilosulose, moderately pustulate-glandular. Racemes solitary to several, 1-7 in number, 1-3 dm long, rachis moderately spreading-pilosulose; pedicels 0.8-1.2 mm long, moderately spreading to appressed pilosulose; bracts narrowly linear, 2.5-3.0 mm long, sparingly pilosulose, pustulate-glandular, caducous. Calyx-tube narrowly funnelform, 2.5-3.0 mm long, moderately spreading-pilosulose throughout, conspicuously pustulate-glandular in upper fifth. Calyx-lobes usually tipped by a resinous, pustulate gland and otherwise eglandular, moderately to sparingly pilosulose or puberulent both externally and internally. Adaxial calycine lobe triangular-dentate, acute to less frequently acuminate, 0.5-1 mm long; lateral lobes longer and more narrowly lanceolate, acuminate, 0.8-1 mm long; abaxial lobe narrowly lanceolate, acuminate, 1.2-2 mm long. Vexillum 5-7 mm long, about 4 mm wide, broadly obovate with a slender claw and a broad, truncate apical notch with a central, triangular-dentate apiculation about 0.1-0.2 mm long, white; the claw enveloping the filaments and the blade either plane or reflexed away from the filaments. Filaments greatly elongate, 8-12 mm long, united for the basal 1-1.5 mm, glabrous; anthers about 0.5 mm long, apparently pale yellow. Style moderately ascending-pilose; ovary glabrous except for the uppermost pilosulose region near the style. Fruit (apparently still immature) about 6 mm long and 2.5 mm wide, broadest above the middle, tapering to base, with the adaxial margin very nearly straight and the abaxial margin gradually outwardly bowed, glabrous or sparingly pilosulose only near the top, conspicuously glandular-pustulate.

Distribution: Known only from the Sierra San Pedro Martir of northern Baja California, Mexico at approximately 31° N. (Map 1, in part.)

This species is clearly very closely related to *Amorpha californica* and especially to that species's var. *californica* which apparently also reaches its southern limit in the

Sierra San Pedro Martir. I have examined only eleven different collections of either species from this area. These two species have been confused both in the field and the herbaria by collectors and identifiers and at the present time one cannot form any realistic picture of their ecologic or spatial arrangement to one another. It does not seem that the two are strictly altitudinally separated from one another but if anything *A. californica* tends to occupy the higher elevations.

The two species can seemingly be readily distinguished from each other vegetatively and either in flower or fruit. Additional collections and field observations from this region are certainly much to be desired.

Although *A. apiculata* seems in some respects to be less strikingly different from *A. californica* var. *californica* than is *A. californica* var. *napensis*, nothing would seem to be gained by attempting to surmise now the results of the needed research. The three taxa form a most distinctive complex within the genus.

3. **Amorpha herbacea** Walt., Fl. Car. 179. 1788.

A shrub mostly (0.3)0.6-1.2(1.5) m high arising from a thick, woody, often horizontal rootstock reportedly up to 2 m in length and 2 cm in diameter. Current season's growth dull reddish-purple, olivaceous to light brown, slender, about (1)2-4 mm in diameter, with numerous fine longitudinal grooves and ridges and sprinkled throughout with few to numerous, usually inconspicuous, small punctate glands, mostly densely short-pubescent or puberulent and then often appearing canescent but occasionally (especially in Florida) only very sparingly pubescent. Leaves numerous, spreading to ascendant, mostly about (0.6)0.8-1.8(2.4) dm long. Petioles mostly densely short-pubescent, puberulent or strigillose but occasionally glabrous or nearly so and with few to numerous postulate glands especially abundant near the base, typically shorter than the width of the lowest leaflet but occasionally as long as 1.5 times the width, about (0.5)1-10(13) mm long. Stipules incon-

spicuous, pigmented like the stem and rachis, glabrous to sparingly pubescent, caducous or persisting as a withered remnant, appressed, acicular to setaceous, about (1)1.2-2.5(3) mm long. Rachis of leaf slender, about 0.5-1 mm in diameter, usually densely short-pubescent or puberulent throughout (or if differentially so, then more densely pubescent above in and about the channeled groove) to less commonly sparsely short-pilose, strigillose or even glabrous or nearly so, sparingly glandular throughout. Leaflets (15) 23-45(63) in number, about (0.7)1.0-2.5(3.2) cm long and (3)4-10(15) mm wide, mostly (1.2)2-3(4) times as long as broad, usually symmetrical but rarely asymmetrical, opposite or alternate, the interval between petiolules on the same side of the rachis about (0.3)0.6-1.2(1.8) cm long. Blades of leaflets mostly broadly to narrowly oblong or occasionally oblong-elliptic to elliptic, or rarely ovate-oblong, ovate, obovate, obcordate or almost orbicular with the base usually broadly rounded to obtuse, occasionally subcordate, truncate or nearly so, oblique or rarely tapering and then more or less acute; the apex obtuse to broadly rounded to almost truncate and occasionally shallowly emarginate, with the midvein terminating in a sessile or subsessile, distinctly swollen, often globose, glandular knob, or, when exserted, the swollen tip on a stalk about 0.2-0.5(0.8) mm long. Texture of leaflets coriaceous to subcoriaceous when dry, finely reticulate above from the very slightly elevated venation excepting the scarcely depressed midvein; the margin usually slightly to conspicuously revolute and very inconspicuously crenulate to entire, or nearly so. Midvein prominently elevated beneath and the secondary veins but slightly raised. Both surfaces of the leaflets usually very densely pubescent, but rarely the upper or even both sides glabrous or very nearly so, and when most nearly glabrous, then often strigillose beneath along the principal veins; pubescence of the upper surface usually short-pilose, puberulent, or even strigillose and that of the lower surface usually short-villous, pilose, puberulent, or rarely strigillose; punctate glands on the lower surface

usually conspicuous and readily apparent to the unaided eye, appearing to be of approximately two size classes, usually numerous but occasionally few, ranging in number from about (40)75-225(425) glands per half-leaflet. Petiolule about (0.7)1-2 mm long, usually densely puberulent, occasionally strigillose, less commonly sparsely puberulent or strigillose and rarely glabrous, with few to numerous pustulate glands. Stipels acicular to setaceous, mostly (0.4)0.8-2 mm long, rarely tardily deciduous, glabrous to puberulent, especially near the base. Racemes usually few to several or occasionally numerous, appearing terminally clustered or occasionally solitary, about (1)4-12(20) in number, mostly appearing slender and elongate, about (0.3)1-1.8(4) dm long and (0.8)1.2-1.8(2) cm in diameter, sessile, subsessile, or on a peduncle 1-4(7) cm long and with a usually densely but occasionally sparsely puberulent, conspicuously ridged and grooved, sparingly pustulate glandular rachis bearing numerous, usually densely clustered, mostly densely short-pubescent to puberulent or occasionally glabrous pedicels about (0.2)0.4-1.2(1.8) mm long, subtended by a caducous, sparsely glandular-punctate, usually sparingly puberulent to short-pubescent, brownish to amber colored, linear-subulate to setaceous bract about (1.2)1.8-2.5(3) mm long. Calyx-tube turbinate to narrowly campanulate or cylindrical, mostly about 1.5-2.5(3) mm high with the abaxial side slightly longer than the adaxial, usually either very densely puberulent or short-pilose throughout, and with the pubescence curly and spreading or, rarely, densely to sparingly minutely strigillose throughout, or the strigillose pubescence restricted to the upper third or half, or (occasionally in Florida) the tube completely glabrous or the lower half or two-thirds of the tube glabrous and the upper portion variously pubescent, bearing few to numerous conspicuous pustular glands scattered throughout the upper one-third to two-thirds of the tube. Calyx-lobes externally usually densely puberulent or short-pubescent and hence the margins not appearing strikingly ciliate or occasionally (especially in the more

glabrous Floridian forms) merely sparsely puberulent and then the margins appearing densely short-ciliate, punctate-glandular, internally the lobes and occasionally the very uppermost portion of the tube densely puberulent to short-pubescent (the tube otherwise glabrous within). Adaxial calyx-lobes usually triangular-dentate and often narrowly so, mostly acute to acuminate but occasionally (most commonly in the Floridian variety with a glabrous calyx-tube) oblong and then obtuse, about (0.4)0.5-1(1.2) mm long; lateral calyx-lobes broadly to narrowly triangular, mostly longer than the adaxial lobes but shorter than the abaxial, acute to acuminate and mostly (0.6)0.8-1.2(1.5) mm long; the abaxial lobe usually narrowly triangular, acute to acuminate and mostly (0.8)1-1.5(2) mm long. Vexillum about (4)5-6(7) mm long and (2)2.5-3.5 mm wide, broadly obcordate and tapering into a narrow claw, strongly arching and incurved laterally, and thus enveloping the inner floral parts with an entire to finely erose margin, blue-violet, purplish-violet to white. Filaments about 6-8 mm long, glabrous. Anthers about (0.3)0.4-0.6(0.8) mm long, yellow to yellowish orange. Pistil about 6 mm long with a sparsely ciliate or puberulent to glabrous ovary about 1 mm high, and broadest at or about the middle and tapering to either end and with a densely antrorsely pubescent style about 5 mm long terminated by a small, truncate, stigmatic tip. Fruit about 4-6 mm long and about 1.8-2.5 mm wide, broadest at or near the middle and tapering to the 1-2 mm stipe-like base, conspicuously pustular-punctate in the upper half or two-thirds, densely short-pubescent to glabrous or nearly so, exceeding the calyx-tube by about 2.5-4 mm, laterally compressed, obliquely obovate to very slightly, crescent-shaped, the adaxial side straight to slightly arched concavely away from the rachis, the abaxial side strongly outwardly bowed, terminated by the often 0.3-0.5 mm persistent base of the style.

Distribution: Dry, open woods, sandhills, or savannahs, typically of the Coastal Plain but occasionally in the Piedmont or mountains from North Carolina south into Florida.

This species, the most widespread of the southeastern dwarf taxa is not morphologically uniform throughout its extensive area. Its variability is most pronounced in Florida.

A striking extreme within the species as interpreted here is that element which was formerly designated *A. floridana*. My earlier survey of the southeastern dwarf species (Rhodora **56**: 261-265. 1954) indicated that *A. floridana* represented a distinct species endemic to the west coast of Florida from about the Apalachicola region south at least to Manatee and Highlands counties. The suggested difference in curvature of the dorsal suture of the fruit employed by Small (Man. SE. Flora 688. 1933.) to distinguish the two taxa is not tenable. The dorsal suture of most fruiting specimens of the *floridana* type is straight, or very nearly so, just as in *A. herbacea*. Only rarely is it as curved as shown by Palmer (Jour. Arn. Arb. **12**: 194. f. 5. 1931). Examination of many more specimens of *A. herbacea s.s.* and of *A. floridana* has convinced me that the difference between these two taxa is merely one of degree of pubescence. However, there are also a small number of specimens which seem at least partially intermediate between these extremes. Macroscopically they appear much closer to extreme *A. floridana* but microscopically the calyx-tubes are pubescent to a varying degree. Some of these tubes are sparsely puberulent or short-villous throughout, while others are sparingly to densely strigillose throughout. These intermediates might indicate introgression from *A. herbacea*, since they are often found in areas in which that taxon is known and are often collected with it. Except for the apparently isolated area of the glabrous extreme about Apalachicola in Franklin County, the range of the so-called *A. floridana* coincides with part of that of *A. herbacea* in western peninsular Florida. I tentatively have distinguished these two less than ideally separable taxa by the following key.

KEY TO THE VARIETIES OF A. HERBACEA

Upper portion of the plant including the leaves usually conspicuously pubescent; calyx-tube densely puberulent to short-pilose; fruit densely to sparsely puberulent or rarely glabrate. ..... 3a. *A. herbacea* var. *herbacea*.

Upper portion of the plant and the leaves appearing glabrous or nearly so, or at least not densely pubescent; calyx-tube glabrous, sparingly puberulent or sparsely to densely minutely strigillose; fruit glabrous. ..... 3b. *A. herbacea* var. *floridana*.

3a. **A. herbacea** var. **herbacea.** TYPIFICATION: Doubtfully present in Walter's Herbarium (BM) as Dr. Carroll E. Wood, Jr. did not see a photograph of a specimen of this distinctive species in the GH photocopy of Walter's Herbarium. A neotype should therefore perhaps be designated.

A. pubescens Willd., Berlin Baumz. 17. 1796.

A. pumila Michx., Fl. Bor. Am. 2: 64. 1803. (*nom. illegit.*, Intern. Code Art. 63). (TYPIFICATION: holotype, P, not seen; phototype, GH!)

A. cyanostachya M. A. Curtis, Boston Jour. Nat. Hist. 1: 140. 1835. TYPIFICATION: **North Carolina:** Wilmington, *M. A. Curtis* s.n. (lectotype, NY!).

A. herbacea var. *α typica* Schneider, Bot. Gaz. 43: 299. 1907.

A. herbacea var. *β Boyntoni* Schneider, Bot. Gaz. 43: 300. 1907. TYPIFICATION: **Florida:** PASCO CO., pine barrens, Richland, *Curtiss* 6664 (lectotype, MO!; isolectotypes, CU!, GA!, GH!, ISC!, MIN!, NEB!, NY!, PHIL!, UC!, US!)

Usually at least the upper portion of the stem densely short-pubescent or puberulent, but occasionally only sparsely pubescent and rarely almost glabrous. Rachis of leaf usually densely short-pubescent or puberulent through-

out or rarely sparsely short-pilose, puberulent or strigillose. Rachis of the inflorescence usually densely short-pubescent or puberulent. Calyx-tube very densely puberulent or short-pilose throughout, and with the pubescence curling and spreading and not at all strigillose. Fruit densely to sparsely puberulent or short-pubescent throughout or in part glabrous.

Typification: Probably not in Walter's Herbarium (BM). Supposedly from the area about Walter's plantation in present day Berkeley County, South Carolina, where it is common.

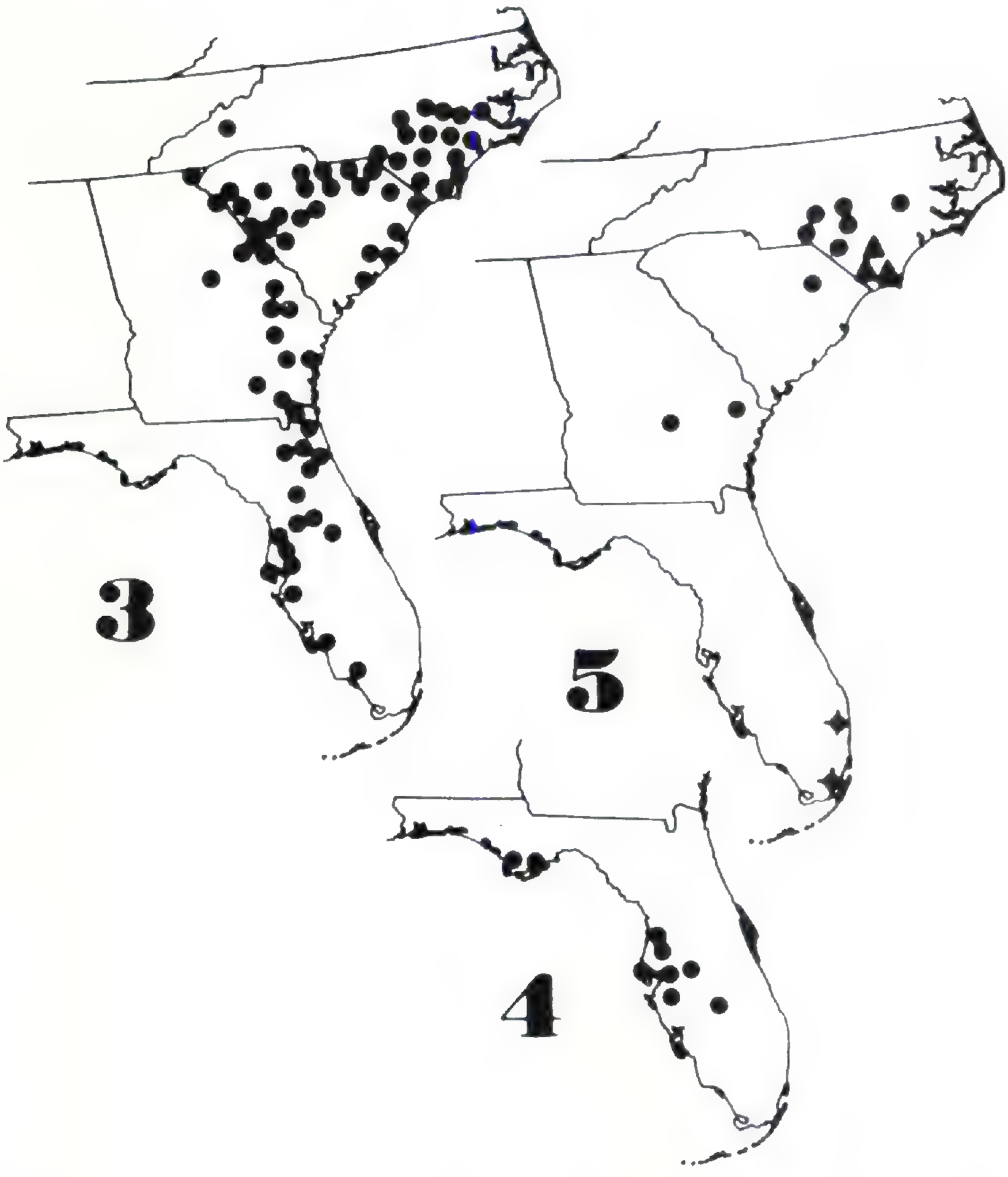
Distribution: Dry, open woods, sandhills, or savannahs, typically of the Coastal Plain but occasionally in the Piedmont and mountains from North Carolina south into peninsular Florida. (Map 3.)

Schneider did not treat his two proposed varieties as distinct species since they were "apparently connected . . . by some intermediate forms." The extremes in leaflet size and number are striking but the transition from one morphological type to the other is complete. The more northern specimens are often separable from those from the southern portion of the range, but exceptions are frequent.

3b. **A. herbacea** var. **floridana** (Rydb.) Wilbur, Jour. Elisha Mitchell Sci. Soc. **80**: 55. 1964.

A. floridana Rydb., N. Am. Fl. **24**: 31. 1919. TYPIFICATION: **Florida:** [no other locality given], *Chapman* s.n. (NY!).

Upper portion of the stem glabrous or nearly so to sparsely short-pilose or puberulent, but occasionally noticeably puberulent or strigillose. Rachis glabrous or nearly so to more or less densely puberulent or short-pubescent, especially above. Rachis of the inflorescence sparsely to



MAPS 3-5. Map 3. *Amorpha herbacea* var. *herbacea*. Map 4. *A. herbacea* var. *floridana*. Map 5. *A. georgiana* var. *georgiana* (dots in the Carolinas and Georgia), *A. georgiana* var. *confusa* (triangles) and *A. crenulata* (dots with vertical and horizontal lines in southern Florida).

densely puberulent. Calyx-tube glabrous or nearly so to sparsely short-puberulent or minutely strigillose throughout, and the pubescence, when present, often restricted to the upper portion of the tube or at least sparsely distributed below, or, if more or less equally dispersed and dense, then the pubescence strigillose.

Distribution: Known definitely only from western Florida from Franklin County to Manatee County in dry pine lands and fields, sandy roadsides. (Specimens of this species collected by Leavenworth [GH, PH], and others [NY] are labeled "East Florida.") (Map 4.)

4. **Amorpha crenulata** Rydb., N. Am. Fl. **24**: 30. 1919.
TYPIFICATION: **Florida:** DADE CO., in hummocks, between Coconut Grove and Cutler, *Small & Wilson* 1898 (holotype, NY!; a presumed isotype, F!).

A low, apparently rhizomatose shrub about 0.4-1.0(1.5) m high. Current season's growth usually dull reddish-purple or more rarely olivaceous, usually slender, 1-2(3) mm in diameter and but sparsely puberulent to glabrous, or very nearly so, with numerous fine longitudinal grooves and ridges and sprinkled throughout with few to numerous small glandular blistered areas; older branches gray to light brownish and less conspicuously lined. Leaves numerous, spreading to ascendant, (0.8)1.5-2.5(3) dm long. Petioles very sparingly puberulent to glabrous and usually longer than the breadth of the lowermost leaflet, but occasionally equaling or exceeded by the breadth of the lowermost leaflet, sparingly glandular throughout and densely so near the base, (0.3)0.8-1.5(1.8) cm long. Stipules inconspicuous and pigmented like the stem and rachis, glabrous, usually caducous, appressed, setaceous to acicular, 1.2-2.2 mm long. Rachis slender, about 0.5-1 mm in diameter, glabrous to sparsely puberulent, usually sparingly glandular, channeled above. Leaflets (19)23-33(41) in number, (0.7)1.2-2.5(4.2) cm long, (2.5)5-9(11) mm wide, mostly (1.2)2-4(5) times as long as broad, remote, usually well separated from the nearest leaflet on the same side of the rachis, the interval between those petiolules about (5)7-17(20) mm long. Blades of leaflets mostly narrowly to broadly oblong or elliptic but varying from almost orbicular to ovate-oblong or obovate, with the base commonly broadly rounded to almost truncate or gradually tapering and

sometimes acute; the apex broadly rounded to almost truncate and commonly emarginate or occasionally somewhat acute, with the midvein terminating in a sessile or subsessile globose glandular knob or exserted 0.2-0.5 mm as a gland-tipped mucro. Texture of leaflets coriaceous to subcoriaceous when dry, finely reticulate above from the slightly elevated venation although the midvein depressed, the margin flat or more typically slightly to conspicuously revolute, usually very noticeably crenate or crenulate. Midvein prominently elevated beneath, the secondary veins but slightly raised. Both surfaces of the leaflets glabrous or rarely very sparsely pubescent beneath along the principal veins; punctate glands on the lower surface usually conspicuous and readily apparent to the unaided eye, appearing roughly of two sizes, varying from dense and very numerous to relatively sparsely scattered and few, ranging mostly between 40-180 punctate glands per half-leaflet. Petiolule glabrous or rarely sparsely pubescent, pustulate-glandular, (1)1.5-2(3) mm long. Stipels acicular, 0.4-1.5 mm long, glabrous, often not long-persisting and the lower often not developing. Racemes solitary or very commonly few to several closely associated, slender and elongate, mostly (0.5)1-2.5(3) dm long and about 0.7-1.8 cm in diameter, sessile or nearly so, or on a peduncle about 1-2 (4) cm long, with a conspicuously ridged and grooved glabrous to very sparingly puberulent rachis bearing numerous densely clustered to more loosely arranged glabrous to very sparsely puberulent pedicels (0.5)1-1.8(2.2) mm long, subtended by a caducous, gland-dotted, brownish to amber-colored, sparsely puberulent, linear-setaceous or narrowly spatulate bract nearly 1.2-2.5 mm long. Calyx-tube turbinate to narrowly campanulate, mostly (2)2.2-3.2(3.5) mm high with the abaxial side slightly longer than the adaxial, glabrous or very nearly so throughout, with the few to numerous punctate glands mostly restricted to the upper half of the tube. Calyx-lobes punctate-glandular, glabrous or very nearly so externally with a densely short-ciliate margin; internally the lobes and uppermost portion of the

tube densely matted-puberulent, the lower portion of the tube glabrous internally. Adaxial lobes triangular-dentate and acute to acuminate to oblong and obtusely rounded and about 0.5-1 mm long; lateral lobes broadly to narrowly triangular and acute to acuminate and mostly about 0.8-1.2 mm long; abaxial lobe usually narrowly triangular and acute or more commonly acuminate, mostly (1)1.2-1.8(2) mm long. Vexillum about (4.5)5-6(7) mm long and 3-4.5 mm wide, very broadly obcordate and tapering abruptly to a slender claw, strongly arched and incurved and enveloping the inner floral parts, the margin irregularly finely erose to almost entire, white to violet-blue. Filaments about 6-9 mm long, glabrous. Anthers about 0.5-0.7 mm long, yellowish. Pistil about 6 mm long with a glabrous ovary about 1 mm high, an antrorsely pubescent style about 5 mm long and a small, capitate, terminal stigma. Fruit about 4-6.5 mm long and 1.8-2.5 mm wide with the base tapered below into a stipe about 1-2 mm long, glabrous, conspicuously punctate-glandular in the upper two-thirds, exceeding the calyx-tube by about 2.5-4 mm, laterally compressed, obliquely obovate, the adaxial side straight or nearly so, the abaxial side strongly outwardly bowed, terminated by the often 0.5 mm long, persistent base of the style.

Distribution: Apparently restricted to Dade County, Florida. (Map 5, in part.)

This appears to be a weakly differentiated species endemic to the southern tip of Florida. It seems very closely related to *A. herbacea* and particularly to the more glabrate variant of that species, var. *floridana*.

5. **Amorpha georgiana** Wilbur, Rhodora **56**: 261. 1954. [10 Jan. 1955]

A low shrub 0.3-1 m high. Current season's growth olivaceous to dull reddish purple, about 1-3 mm in diameter, very sparsely puberulent or more commonly glabrous with numerous fine longitudinal grooves and ridges and sparsely sprinkled with small punctate glands; the older growth

glabrous, dull reddish purple or brownish and less noticeably ridged and occasionally, especially in the southern portion of its range, persisting for one or perhaps more years and then darker and often grayish or black. Leaves numerous, spreading to ascendant, mostly (3)6-15(18) cm long. Petioles glabrous or sparsely to moderately puberulent or short-pubescent, ranging in length from practically absent to two or more times longer than the breadth of the lowermost leaflet, varying from 1-15(20) mm long, sparingly glandular to densely so especially at or near the base. Stipules inconspicuous, glabrous, caducous to semipersistent, appressed, linear-subulate or more commonly setaceous, mostly about (1)1.5-2(2.5) mm long. Rachis slender, about 0.5-1 mm in diameter, glabrous to sparingly strigillose, puberulent or short-pubescent below and the channeled groove similar or rather densely short-puberulent, sparingly glandular throughout. Leaflets varying from about (11)15-43(47) in number, (0.3)0.6-2.5(3.2) cm long and (0.2)0.6-1.2(1.6) cm wide, usually about (1)1.5-2.5(3) times as long as wide, opposite or nearly so to conspicuously alternate, approximate and often imbricately overlapping with an interval between petiolules of (0.2)0.3-0.5(0.6) cm to rather widely separated with the interval between petiolules on the same side of the rachis about (0.5)0.8-1.4(1.8) cm long. Blades of the leaflets mostly broadly to narrowly oblong or occasionally oblong-elliptic to elliptic and rarely ovate-oblong, or the terminal sometimes obovate, obcordate or even nearly orbicular, with the base broadly rounded or almost truncate to subcordate and the apex usually obtuse to broadly rounded and commonly slightly emarginate with the midvein exserted as a slender mucro about (0.2)0.4-1 mm long and tapering gradually to the not at all or rarely very indistinctly swollen, globose or knob-like tip. Texture of leaflets coriaceous to subcoriaceous when dried; inconspicuously reticulate above from the scarcely elevated venation except for the sometimes but slightly depressed midvein; the margin usually slightly to conspicuously revolute although occa-

sionally flat or nearly so; entire or inconspicuously crenulate and with the midvein prominently and the secondary veins slightly elevated beneath; at maturity both surfaces glabrous or nearly so, or with the lower surfaces sparsely to moderately strigillose, especially along the principal veins, or rarely moderately spreading, short-pubescent, the punctate glands on the lower surface usually inconspicuous but still noticeable to the unaided eye and of uniform size, or at least not conspicuously of two size-classes, mostly about (30)50-120(160) glands per half-leaflet. Petiolule glabrous or sparsely to densely strigillose, puberulent or pilosulose with few to numerous conspicuous to very inconspicuous pustulate glands, 0.7-1.8(2) mm long. Stipels acicular or setaceous, glabrous, usually persistent, mostly 0.8-1.8 mm long. Racemes usually with densely clustered flowers or less commonly with the flowers more loosely arranged, usually appearing terminally clustered and arising from the naked upper portion of the stem or from the axils of the upper leaves or occasionally solitary, varying in number from (1)4-11(15), mostly (0.2)0.5-2.0(3.0) dm long and about (1.0)1.2-1.6 cm in diameter, sessile or nearly so or on a peduncle up to about 8 cm long, the rachis conspicuously ridged and grooved, glabrous or nearly so to sparsely strigillose or puberulent or less commonly densely puberulent, sparingly glandular, bearing numerous, glabrous to sparingly strigillose or puberulent pedicels about 0.4-1 mm long subtended by a caducous, sparingly if at all glandular-punctate, sparsely short-pubescent and often merely ciliate, brownish to amber-colored, linear to linear-subulate bract mostly 1.5-2.5(3) mm long. Calyx-tube turbinate, narrowly campanulate or cylindrical, about 1.7-2.2 mm high with the abaxial side slightly longer than the adaxial, glabrous or rarely inconspicuously and very sparingly pilosulose, bearing few to numerous more or less inconspicuous pustular glands on the upper third to two-thirds of the tube. Calyx-lobes externally glabrous to puberulent (if the latter, usually sparingly so), and usually

punctate glandular and with densely white-ciliate margins; internally the lobes and occasionally even the uppermost portion of the tube densely puberulent to short-pubescent (with the tube otherwise glabrous within). Adaxial calyx-lobes either triangular-dentate and acute to acuminate or oblong, and then obtuse to rounded, mostly 0.4-0.8(1.3) mm long; lateral lobes usually longer than the adaxial lobes and shorter than the abaxial, usually triangular-dentate and acute to acuminate but occasionally oblong and obtuse to rounded, mostly (0.6)0.8-1.2(1.5) mm long; abaxial lobe usually narrowly triangular to lance-subulate, acute or more typically acuminate, mostly (1.0)1.2-1.6(1.8) mm long. Vexillum about (4)5-6 mm long and 3-3.5(4) mm wide, broadly obovate to obcordate, tapering abruptly into a narrow claw, strongly arching and incurving laterally and thus enveloping the inner floral parts, strikingly to inconspicuously emarginate, the margins entire to very finely erose, purplish-blue, bluish or violet in color. Filaments about 5-8 mm long, glabrous. Anthers about 0.4-0.6 (0.7) mm long, exserted, yellowish prior to pollen discharge. Pistil about 6 mm long with a glabrous ovary about 0.8-1 mm high, including the somewhat stipitate base, broadest above the middle, with an antrorsely pubescent style about 4-5 mm long terminated by a small, truncate, stigmatic tip. Fruit about 4-5.5 mm long and 2-2.5 mm wide, broadest at or near the apex and tapering to the 1-2 mm stipe-like base, glabrous, conspicuously punctate-glandular in the upper half or two-thirds, exceeding the calyx-tube by about 2.2-3.5 mm, laterally compressed, obliquely obovate, the adaxial side straight or nearly so, the abaxial side strongly outwardly bowed, usually terminated by the 0.2-0.5 mm long, persistent base of the style.

Distribution: Sandy wire-grass savannahs, pine woods, and thickets in the Coastal Plain from southeastern North Carolina southward into eastern Georgia.

This species seems to be represented by two varieties which are distinguished in the following key:

KEY TO THE VARIETIES OF A. GEORGIANA

Lateral leaflets (3)6-10(15) mm long and (2)3-5(8) mm wide; petioles 1-3(5) mm long; racemes typically solitary but rarely with 1-3 short, additional racemes, mostly (2)3-5(6) cm long; vexillum reddish-purple. . . . . 5a. var. *georgiana*.

Lateral leaflets typically (10)15-25(35) mm long and (7)9-15(18) mm wide; petioles usually (6)8-15(20) mm long; racemes in clusters of (1)3-5(8), 10-20(30) cm long; vexillum light to more typically an intense bright blue. . . . . 5b. var. *confusa*.

5a. **A. georgiana** var. **georgiana.** TYPIFICATION: **Georgia:** TELFAIR CO., sandy wire-grass savannah about 3 miles northwest of Lumber City, *Wilbur* 3158 (holotype, GH!; isotypes, DUKE!, GA!, MICH!, MO!, NSC!, NY!, US!).

Distribution: Sandy flats bordering streams and lowland woods from the central Coastal Plain of North Carolina south into central coastal Georgia. (Map 5, in part.)

5b. **A. georgiana** var. **confusa** Wilbur, Jour. Elisha Mitchell Sci. Soc. **80:** 58. 1964. TYPIFICATION: **North Carolina:** BRUNSWICK CO., grassy savannah, 7 miles southwest of Wilmington, *Godfrey & Shunk* 4122 (holotype, GH!; isotype, US!).

A. glabra in the sense of Boynton, Bot. Gaz. **25:** 279. 1898 and in Small's Fl. SE. U.S. 626. 1903, but not of Poiret, Encycl. Méth. Suppl. **1:** 330. 1810.

A. caroliniana in the sense of T. & G. Fl. N. Am. **1:** 305. 1838 in part; Schneider, Bot. Gaz. **43:** 302. 1907 and Ill. Handb. Laubh. **2:** 74. 1907; Rydb., N. Am. Fl. **24:** 29. 1919, but not of Croom, Am. Jour. Sci. **25:** 74. 1834.

A. cyanostachya in the sense of Palmer, Jour. Arn. Arb. **12:** 169. 1931, and of Small, Man. SE. Fl. 639. 1933, but not of M. A. Curtis, Boston Jour. Nat. Hist. **1:** 140. 1835.

Distribution: Pine woods, sandy ridges, savannahs, and sandy roadbanks of southeastern North Carolina (Bladen, Brunswick, and Columbus Counties). (Map 5, in part.)

The confused basis of the previous names applied to this taxon has been discussed rather fully in an earlier paper (Jour. Elisha Mitchell Sci. Soc. 80: 58-61. 1964) and there is no need to repeat that discussion here. Although, I remain skeptical that the present arrangement of the *georgiana* and *confusa* taxa will prove to be satisfactory when more is learned about them, I refrain from further nomenclatural shifts at the present time. I suspect future investigation may well demonstrate that the two taxa are specifically distinct. Perhaps I am overly impressed by the strikingly different colors of their petals.

6. **Amorpha canescens** Pursh, Fl. Am. Sept. 467. 1814.
Typification: Not seen. Perhaps in Pursh's collection but Nuttall (Gen. N. Am. Pl. 2: 92. 1818) states that "Mr. Pursh places his usual mark of v.v. to this species, although he has never seen a flowering specimen except in my herbarium." "On the banks of the Missouri and Mississippi," Pursh; and "From the banks of Fox River and the Quisconsin [Wisconsin River] to the Mississippi; around St. Louis, Louisiana, and on the banks of the Missouri probably to the Mountains," according to Nuttall.

A. canescens Nutt., Fraser's Cat. no. 4. 1813. *nom. nud.*

A. canescens var. *β leptostachya* A. Gray, Mem. Am. Acad. II. 4: 31. 1849. *nom. nud.*

A. canescens var. *glabrata* A. Gray, Smithson. Contr. Knowl. 3 (Art. 5, Pl. Wright): 49. 1852. TYPIFICATION: eastern Texas, *Charles Wright*, not seen.

A. canescens var. *α typica* C. K. Schneid, Bot. Gaz. 43: 300. 1907.

A. brachycarpa Palmer, Jour. Arnold Arb. 12: 171. 1931. TYPIFICATION: **Missouri:** STONE CO., dry

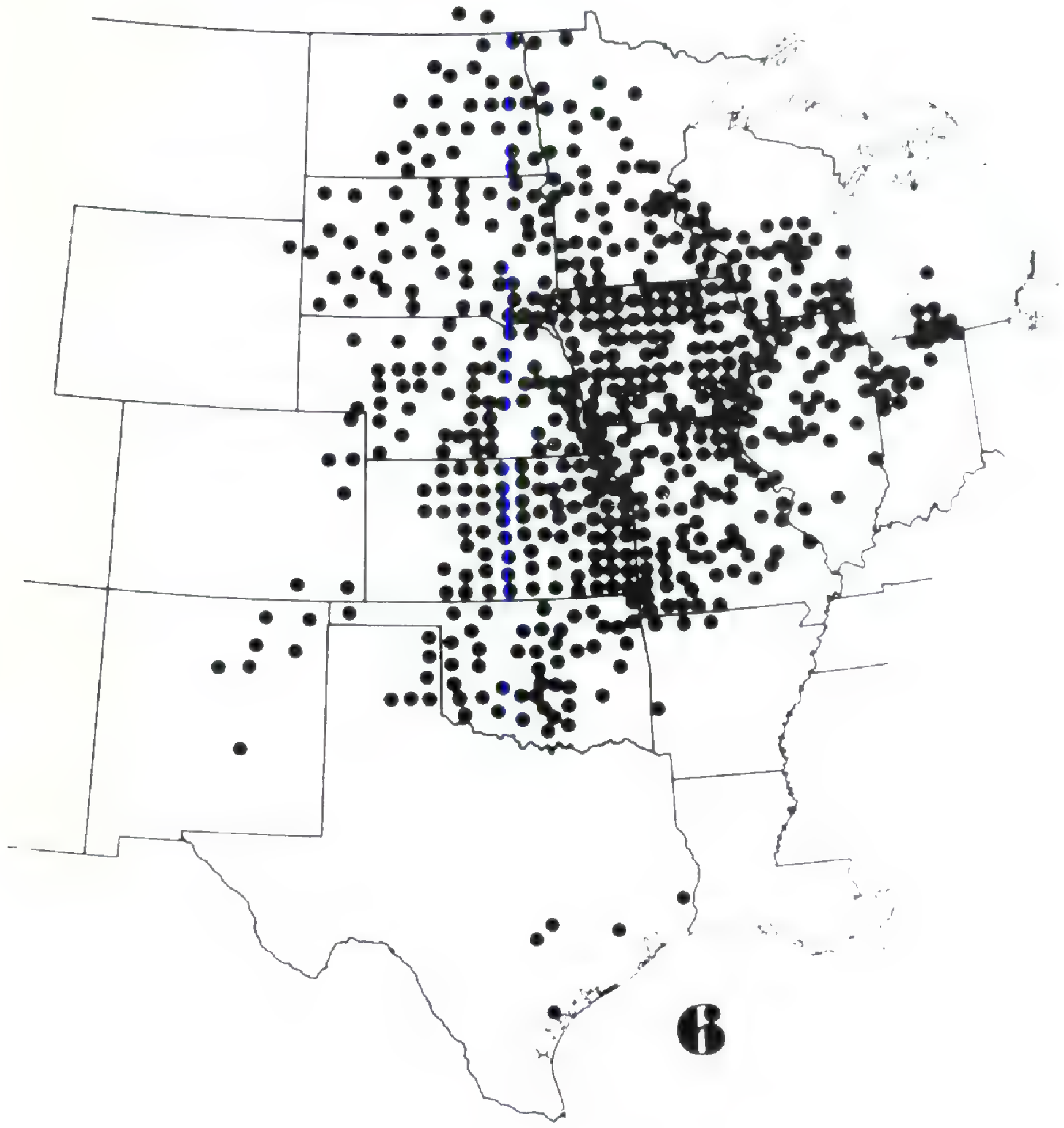
slopes and ledges, rocky hills near Galena, *E. J. Palmer* 19197 (holotype, A!; isotypes, KANU!, MIN!, US!).

A. canescens f. *glabrata* (A. Gray) Fassett, Rhodora 38: 191. 1936.

A low, ascendant to erect, apparently rhizomatose, usually canescent, shrub mostly about (3)5-8(10) dm high. Current season's growth light brown to olivaceous and slender (about (1)2-3 mm in diameter) and typically very densely grayish tomentose or occasionally but moderately so or very rarely glabrous or nearly so, with numerous very fine longitudinal striations and apparently eglandular or at most with very few minute, amber-colored, very inconspicuous glands; older branches mostly light gray to brownish and very slightly, if at all, lined, glabrous or very nearly so. Leaves numerous, spreading, about (3.0)6.0-12.0(15.0) cm long. Petioles whitish to pale gray, moderately to very densely tangled tomentose, villous or even-spreading short-pubescent or very rarely moderately puberulent to spreading short-pilose, sometimes equaling but usually very much shorter than the breadth of the lowermost leaflet, apparently always lacking pustulate glands, mostly (0.5)1-3(5) mm long. Stipules inconspicuous, caducous, densely canescent-pilose externally, glabrous, dark reddish and amber-colored within, initially appressed but spreading and often becoming reflexed with age, linear-lanceolate, linear to setaceous, mostly (1.2)2-3(3.5) mm long, pustular glands apparently always lacking. Rachis of leaf slender, mostly about (0.2)0.5-1.0(1.2) mm in diameter, usually very densely grayish, tangled-tomentose but occasionally varying to sparingly so to even strigillose or spreading puberulent, channeled above, pustular glands apparently always absent. Leaflets mostly (11)27-41(47) in number, usually about (0.3)1.0-1.8(2.5) cm long and (2.0)4.0-7.0(12.0) mm wide, usually about (1.8)2.0-3.0(3.8) times as long as broad, typically crowded and commonly overlapping one another, the interval between peti-

olules on the same side of the rachis characteristically about (2.0)3.0-8.0(10.0) mm long. Blades of leaflets mostly ovate-oblong, oblong-elliptic, oblong, elliptic, or even ovate with the terminal rarely obcordate and those of the dwarf suckers often almost suborbicular to obovate, with the base obtuse to broadly rounded, and more rarely subcordate or even somewhat truncate and the apex obtuse to broadly rounded but rarely acute or even emarginate with the midvein exserted into a slender tapering mucro (rarely slightly swollen at tip on a few leaflets) usually about (0.2)0.4-0.8(1.2) mm long. Texture of leaflet subcoriaceous to thick-membranous when dry, venation often completely obscured or nearly so by the dense pubescence, but when discernible usually only finely and inconspicuously reticulate above from the slightly elevated secondary and tertiary venation (the midvein somewhat depressed); the margin flat to very slightly revolute and entire; the midvein markedly elevated beneath and the secondary and tertiary venation often forming an inconspicuous net (which is usually completely obscured or nearly so by the dense pubescence); both surfaces usually very densely grayish tomentose and then appearing canescent to less commonly moderately short-pubescent or very rarely nearly glabrous with pubescence restricted to the midvein and sometimes principal veins and to the margin, and the leaves then greenish (the pubescence usually both denser and longer below than above); pustular-punctate glands usually present beneath, although completely obscured from view by the tangled pubescence, when not hidden by pubescence still relatively inconspicuous, light olive-green or brown in color, more or less of uniform size, very small. Petiolules very densely spreading pilose to short-pubescent but rarely sparingly short-pubescent, usually appearing canescent, mostly (0.5)0.8-1.2 mm long, usually lacking punctate glands or glands, if present, very inconspicuous. Stipels acicular, about (0.5)0.8-1.2(1.5) mm long, mostly slightly exceeding but sometimes almost twice as long as the petiolule, glabrous to sparsely short-pubescent, long-persistent,

dark reddish brown, the lower rarely developing beyond the swollen base. Racemes usually numerous in the axils of the uppermost leaves and often forming a dense compound cluster, mostly (1)5-20(30) or even more in number, very densely flowered, mostly (2.0)7.0-15(25) cm long and about 1-1.5 cm thick; peduncle short, mostly about 1-5(8) cm long; rachis strongly ridged and grooved, very densely spreading-pilose to short-pubescent, sparingly and very inconspicuously glandular-punctate and bearing numerous, very densely arranged, moderately to (more typically) densely spreading, wavy, short-pubescent or pilose pedicels appearing short and stout with a truncate apex, about (0.4)0.6-1.2(1.5) mm long, subtended by a caducous, sparsely glandular-pustulate, amber-colored, moderately to densely pilose externally and glabrous within, linear-setaceous to narrowly lanceolate (with a long tapering apex) bract mostly (2.5)3.0-4.0(4.5) mm long. Calyx-tube turbinate to obconic-campanulate, mostly (1.5)1.8-2(2.5) mm high, slightly asymmetrical with the abaxial slightly longer than the adaxial, usually very densely canescent throughout, but very rarely sparingly pilose to almost glabrous (the trichomes mostly spreading short- to long-pilose), usually rather inconspicuously (due to the pubescence) punctate-glandular, internally glabrous except for possibly the uppermost fringe. Calyx-lobes all narrowly triangular-lanceolate, obscurely punctate-glandular and acute; adaxial lobes (0.6)1-1.4(1.6) mm long; lateral lobes (1.0)1.2-1.5(1.8) mm long; abaxial lobe (1.2)1.5-2.2(2.5) mm long, all very densely canescent, short- to long-pilose externally and internally more sparingly pilose. Vexillum about 4.5-6.0 mm long and 2.5-4 mm wide, very broadly obcordate and abruptly tapering into a slender claw (about 1-1.5 mm long), strongly arched and incurved, enveloping the inner floral parts, its apex usually somewhat emarginate but occasionally also obscurely apiculate, its margin entire to irregularly erose, bright violet. Filaments golden-brownish to purplish, about 6-8 mm long, glabrous, united into a tube for the lowest 1.5-2.0 mm. Anthers about 0.4-



MAP 6. *Amorpha canescens.*

0.8 mm long, yellowish to golden brown. Pistil about 5.0-7.0 mm long with densely pilose ovary about 1 mm high, a densely antrorsely pubescent style about 4-6 mm long and a small, capitate, terminal stigma. Fruit about (3.0)3.5-4.5(5.0) mm long and (1.5)1.8-2.2 mm wide, tapering to the somewhat stipe-like base, usually densely to moderately villous-canescent but very rarely glabrous, punctate-glandular in the upper half or two-thirds, exceeding the calyx-tube by 2-3.5 mm, with the adaxial straight or very nearly so and the abaxial side strongly outwardly bowed, terminated by the 0.5-1.5 mm long, persistent base of the style.

Distribution: Roadsides, fields, prairies, hillsides, and open woodlands from Indiana west into the Dakotas, Wyoming, and New Mexico, and southern Canada south into eastern Texas. (Map 6.)

The reasons for recognizing neither *A. canescens* var. *glabrata* A. Gray nor *A. brachycarpa* have been presented in an earlier paper (Jour. Elisha Mitchell Sci. Soc. 80: 62-63. 1964) and will not be repeated here.

An apparently rarely encountered hybrid between *A. canescens* and *A. fruticosa* may be better discussed here than elsewhere since the overall aspect of the plant is such that it most likely would be taken as an aberrant, oversized *A. canescens*. The rarity of the supposed hybrid certainly attests to the effectiveness of the isolating mechanisms between the two species for they occupy the same general geographical area over a very extensive region of the central United States.

Palmer (Rhodora 55: 158-159. 1953) described the hybrid of these two species as *Amorpha* × *notha* from a single plant found on a "low rocky bank between upland prairie and alluvial valley of Center Creek, about 1 mile north of Webb City, Jasper Co., Missouri." Both species are common in southwestern Missouri and yet Palmer, who was extremely familiar with the plants of that area and who had a particular interest in *Amorpha*, knew only one example of the hybrid. In addition to the two collection numbers made by Palmer from the type plant (*Palmer* 52047, 27 May 1951, in flower; isotypes, F, MO, SMU, UMO); and *Palmer* 52930, 9 August 1951, in fruit (F, UMO). Palmer made an additional collection (#56605) from the same area, if not from the same plant, two years later. Another collection which I take to represent this hybrid was collected by Palmer, #25305, 4 June 1924: dry rocky ledges, limestone bluffs of Spring River, near Melugin, Jasper Co., Missouri (A, MIN, UMO) and was cited, mistakenly, I believe, (Jour. Arnold Arb. 12: 167. 1931) as *A. canescens* var. *glabrata* A. Gray.

The hybrid differs from *A. canescens* with which it has the greatest overall affinity in its taller habit, much shorter calyx-lobes and particularly in its dorsally strongly curved fruit. From its *A. fruticosa* parentage, it differs in densely canescent, pilosulose calyx-tube as well as the finely canescent leaves and young stems. The practice of giving binomials to hybrids of this sort has, I believe, very little to recommend itself as a botanical custom.

7. **Amorpha nana** Nutt., Fraser's Cat. 1813. TYPIFICATION: "Collected near the Mandan towns, 1600 miles up the Missourie," *Nuttall*, not seen.

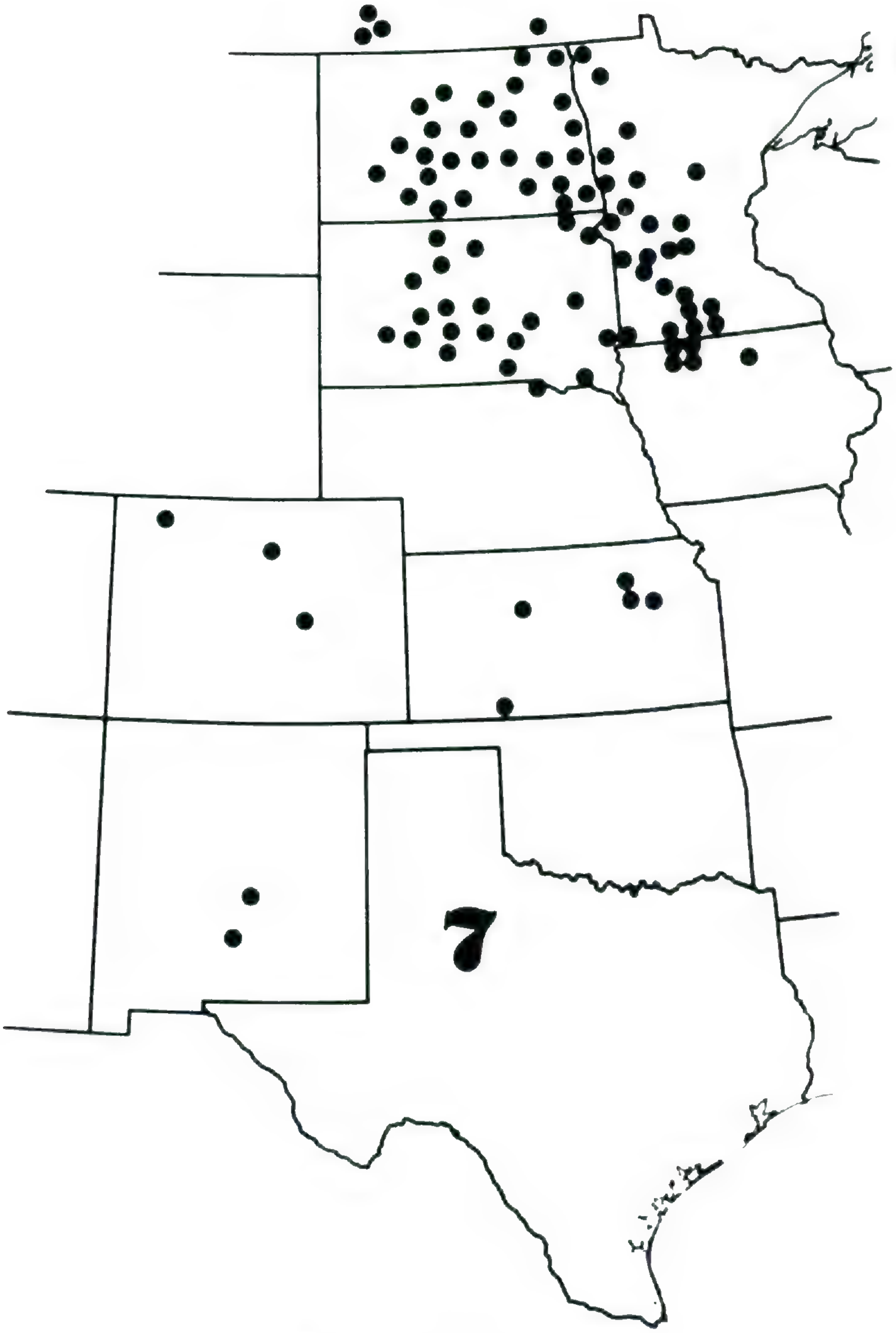
   A. microphylla Pursh. Fl. Am. Sept. 466. 1814. *nom. illegit.*, Art. 63. TYPIFICATION: not seen; Pursh stated that he based name on a specimen presented to him by Meriwether Lewis of the Lewis and Clark Expedition.

   A. punctata Raf., New Fl. 3: 14. 1837. TYPIFICATION: Specimen not seen. "Discovered by Bradbury in the upper Missouri."

A low, erect, apparently rhizomatose shrub aobut 3-6 (9) dm high. Branches of the current season light reddish-brown to pale olivaceous; clustered near the top of the stem; slender (about 1-2(3) mm in diameter), sparsely or, more typically, moderately strigillose but becoming glabrate below with age and with numerous very fine, longitudinal grooves and ridges and a sparse to moderate sprinkling of small inconspicuous punctate-pustular, amber-colored glands; older branches usually light gray or pale brownish, only slightly, if at all, lined. Leaves numerous, spreading to ascendant, (1.5)3-7(10) cm long. Petioles sparsely to densely strigillose or somewhat finely spreading-puberulent, becoming glabrous or nearly so, equaling or usually longer than the breadth of the lowermost leaflet (rarely the breadth of leaflet is greater than length of petiole), about (2)4-8(10) mm long, very sparingly pustulate-glandular. Stipules inconspicuous, pigmented like the

young stem and petiole, caducous, short-pubescent along margins and outer surface and often with a moderately long tuft of trichomes near tip, appressed to spreading, setaceous to linear, (2)3-5(6.5) mm long, occasionally sparingly pustulate-glandular. Rachis of leaf very slender, mostly about 0.3-0.7 mm in diameter, glabrous or nearly so to densely very short-puberulent or strigillose and sparingly to moderately beset with minute pustular-glands, channeled above. Leaflets mostly (7)13-27(31) in number, (2)6-13(18) mm long, (2)3-6(7.5) mm wide, usually (1) 1.8-2.9(3.5) times as long as broad, rarely overlapping to more commonly remote, usually the interval between petiolules on the same side of the rachis about (3)4-7(9) mm long. Blade of leaflet mostly narrowly to broadly oblong or even somewhat elliptical but occasionally varying to ovate or obovate to almost orbicular, with the base usually rounded or occasionally with margins gradually tapering and with the base then cuneate, the apex usually broadly rounded or even truncate and commonly emarginate but occasionally acute, with the midvein exserted into a slender, tapering mucro usually about (0.6)0.8-1.2(1.5) mm long. Texture of leaflet coriaceous to subcoriaceous when dry, finely and inconspicuously reticulate above from the somewhat elevated secondary and tertiary venation (the midvein somewhat depressed), the margin flat or more typically somewhat revolute and entire to inconspicuously crenulate; the midvein conspicuously elevated beneath and with the secondary and sometimes the tertiary veins somewhat elevated and sometimes forming an inconspicuous net; surface glabrous on both sides but the midvein beneath and the margin usually sparingly short-pubescent, puberulent or somewhat strigillose or rarely glabrous or nearly so; the punctate glands conspicuous and readily visible to the unaided eye on the lower surface, appearing to be of uniform size or at least not falling mostly into two more or less distinct size classes, usually with about (10)20-35(55) punctate glands per half-leaflet. Petiolule densely to sparingly short-pubescent or strigillose and sometimes becoming

glabrate with usually few to several small pustulate glands and mostly about (0.5)0.7-1 mm long. Stipels acicular, about (1.0)1.5-2.5(3) mm long, often 2 times or more as long as the petiolule, glabrous, long-persistent. Racemes solitary at the tips of the current season's growth, contracted and very densely flowered, mostly (2.0)3-7(9) cm long and about 1-1.5 cm in diameter, subsessile or the peduncle about 0.3-1.5(2.0) cm long; rachis conspicuously ridged and grooved, moderately to very densely puberulent or occasionally strigillose; pedicels bearing numerous very densely clustered, moderately to densely puberulent or strigillose (often becoming sparsely so or even glabrate in fruit), often long-persistent (and with a truncate, somewhat expanded apex), about 1.0-2.0(2.5) mm long, subtended by a caducous, sparsely glandular-pustulate, brownish to amber-colored, moderately to densely puberulent, linear-setaceous to narrowly spatulate bract mostly (2.5) 3.0-4.0(5.0) mm long with a long, tapering apex. Calyx-tube turbinate, mostly 1.8-2.2 mm high with the abaxial side slightly longer than the adaxial, glabrous throughout with few to more usually numerous punctate glands mostly arranged in rows and restricted to the upper half of the tube. Calyx-lobes all narrowly triangular-lanceolate and acute, punctate-glandular, glabrous or very sparsely puberulent externally but with densely short-ciliate margins; internally the lobes and the very uppermost portion of the tube densely matted short-puberulent and the lower portion of the tube internally (as well as externally) glabrous; adaxial lobes about (0.8)1.0-1.5(1.8) mm long; lateral lobes mostly (1.0)1.2-1.8(2.0) mm long; abaxial lobe (1.5)1.8-2.0(2.2) mm long. Vexillum about 4.5-6.0 mm long and 3.5-4.5 mm wide, very broadly obcordate, abruptly tapering into a slender claw, strongly arched and incurved and enveloping the inner floral parts, its margin emarginate and usually finely erose, dark purple. Filaments purplish, about 6-8 mm long, glabrous; anthers about 0.4-0.6 mm long, purplish. Pistil about 4.0-6.0 mm long with a glabrous ovary about 0.8 mm high, an antrorsely pubescent



MAP 7. *Amorpha nana.*

style about 3.5-5 mm long and a small, capitate, terminal stigma. Fruit about 4.5-5.5 mm long and 2.0-2.8 mm wide, oblongish but tapering to a stipe-like base of about 0.5 mm long, glabrous, conspicuously punctate-glandular in the upper two-thirds, exceeding the calyx-tube by about 2.0-3.5 mm, the adaxial side straight or nearly so, the abaxial side strongly outwardly bowed, terminated by persistent base of the style, this about 0.5 mm long.

Distribution: Prairies, hillsides, plains, and buttes from Iowa and Minnesota west into the Dakotas and Colorado and from southern Manitoba and Saskatchewan south into New Mexico; primarily a plant of the northern plains. (Map 7.)

8. **Amorpha glabra** Poir., Encycl, Meth. Suppl. **1**: 330. 1810.
TYPIFICATION: type not seen, perhaps at P; based on a specimen grown in cultivation in Paris.

?*A. glabra* Desf., Tabl. Ecole Bot. Paris 192. 1804, *nom. nud.*

?*A. glabra* Pers., Syn. Pl. 2: 295. 1807. *nom semi-nud.*

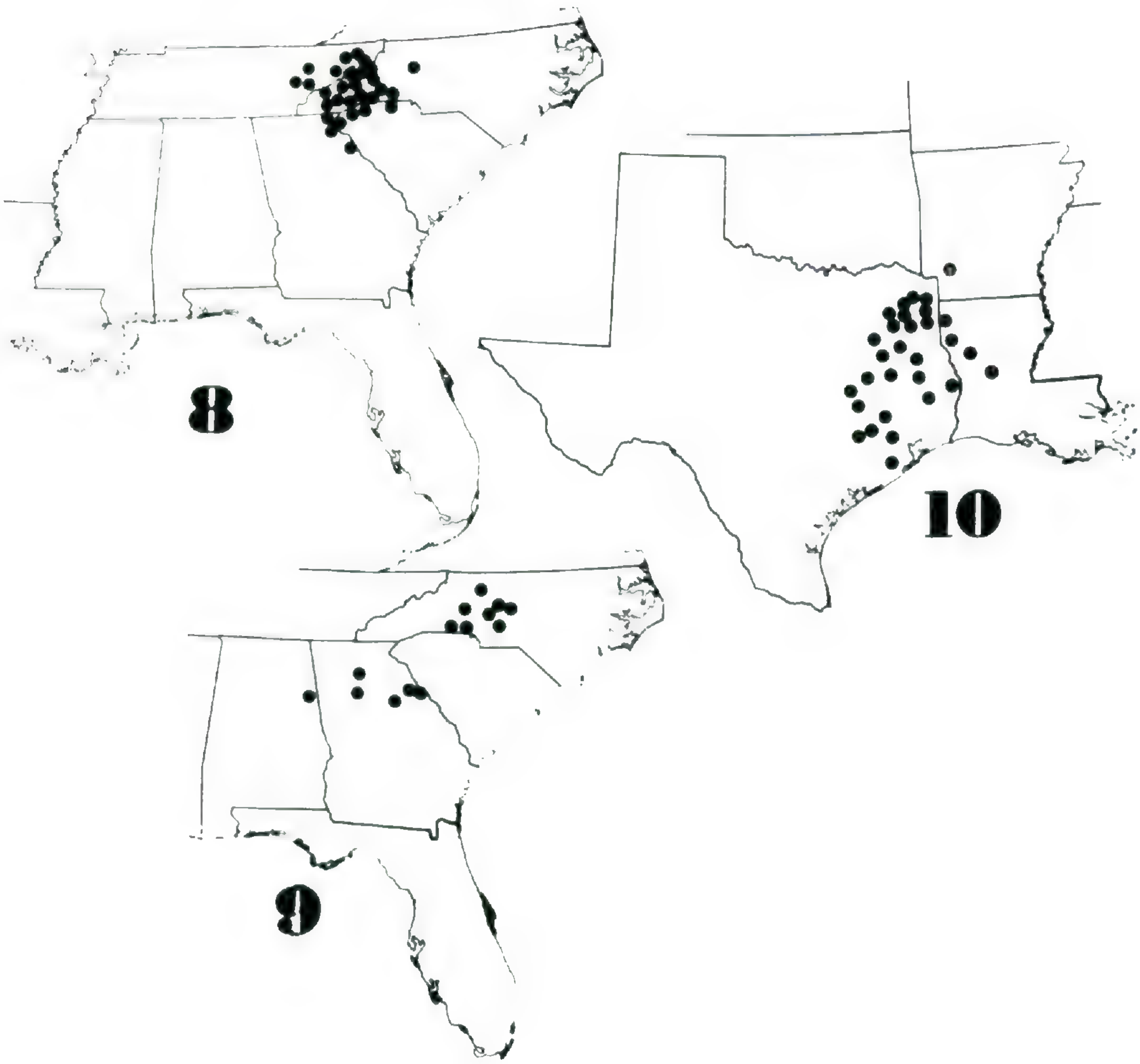
A. montana Boynt., Biltmore Bot. Stud. 1: 138. 1902. TYPIFICATION: **North Carolina:** rocky woods, Biltmore, *Biltmore Herb.* 14 (lectotype, US!; fruiting specimen collected 29 August 1896 on sheet numbered 331562; isolectotypes, A!, CU!, GH!, MIN!, MO!, ND-Greene!, NY!, RM!, US!).

?*A. fruticosa* var. *glabra* Bean, Trees and Shrubs Brit. Isles 1: 193. 1914.

A much-branched, erect shrub mostly 1-2 m high. Current season's growth light to dark purplish or light-brown to olivaceous, slender to moderately thickened, about 1-2 (3) mm in diameter, usually completely glabrous or at most very sparsely and obscurely strigillose to puberulent, sparingly, if at all, beset with inconspicuous, minute, amber-colored pustulate glands; branches of the preceding year

mostly grayish to blackish. Leaves wide-spreading, mostly (1.0)1.4-2.2(3.0) dm long. Petioles mostly (1.6)2.0-4.0 (5.7) cm long, typically much longer than the width of the lowermost leaflet, glabrous or very nearly so or very sparingly puberulent, sparsely beset, if at all, with amber-colored pustulate-glands. Stipules inconspicuous, appressed when present, caducous, thin, sparsely to moderately puberulent to short-pubescent on margins and outer surface, dark reddish-brown, typically linear to linear-lanceolate, about 2.5-4.5 mm long, apparently eglandular. Rachis of leaf about 0.5-1.0 mm in diameter, usually greenish-olivaceous, glabrous or rarely at most exceedingly sparingly puberulent or strigillose, usually sparingly glandular pustulate throughout, interval between petiolules on the same side of the rachis about (0.8)1.5-3.0(3.6) cm long. Leaflets mostly (7)11-15(21), either opposite or alternate, about (1.4)2.2-4.6(7.4) cm long and (1.0)1.4-2.8(3.6) cm wide, mostly (1.2)1.4-2.2(2.7) times as long as broad, characteristically widely spaced and not overlapping, usually broadly oblong, oblong-elliptic to elliptic or less commonly ovate-oblong to ovate or rarely nearly orbicular, basally typically very broadly rounded to truncate or nearly so or even subcordate but rarely gradually tapering to even acute, apically very broadly rounded to strongly obtuse and almost invariably conspicuously emarginate. Midvein usually terminating in a swollen, globose, glandular tip either sessile or exserted on a stalk about 0.2-0.4 mm long. Both surfaces with venation scarcely either elevated or depressed on either surface except for the conspicuously elevated midvein and the primary and secondary veins obscurely reticulate, glabrous or rarely sparsely and inconspicuously strigillose beneath along the midvein and principal lateral veins, usually conspicuously glandular-punctate; punctate glands variable in size, usually numerous, mostly ranging in number from about (30)50-150(300) glands per half-leaflet. Margin entire, inconspicuously and finely undulate to conspicuously crenulate, slightly revolute to more or less flush-margined. Petiolules about 2.0-4.0(5.5) mm long,

usually glabrous but occasionally sparingly to moderately puberulent or strigillose, mostly sparsely glandular-pustuate, wrinkled when dried. Stipels acicular to setaceous, mostly 1.2-2.0 mm long (but the tips quickly caducous and thus appearing shorter), glabrous, usually long-persistent, dark reddish-brown. Racemes often solitary and terminal or few and terminally clustered, 1-3(4) in number, with densely clustered flowers, mostly about (0.5)1.0-1.8(2.8) dm long and 1.2-2.0 cm in diameter, sessile or nearly so or with a peduncle 1-6 cm long; rachis sparsely glandular-punctate, glabrous or very sparingly strigillose or puberulent. Pedicels glabrous or at most sparsely strigillose or puberulent, usually eglandular, about (0.8)1.0-2.5(3.0) mm long; bracts caducous, apparently eglandular, golden-brown, usually puberulent or ciliate, linear-oblong or linear-lanceolate, about (0.5)0.8-1.5(2.0) mm long. Calyx-tube broadly turbinate or campanulate, mostly (2.0)2.2-3.0 (3.2) mm high, somewhat asymmetrical with the abaxial side slightly higher than the adaxial, glabrous externally and internally throughout excepting the densely short-ciliate rim, bearing 1 or 2 rows of small, inconspicuous, pustulate-glands mostly restricted to the upper third of the tube. Calyx-lobes often obsolete or nearly so and the top of the calyx then appearing truncate or the lobes low and depressed with the calyx-rim appearing weakly undulate but when noticeably developed usually broader than high, mostly rounded or broadly triangular-dentate; adaxial lobes often rounded and shorter than the lateral lobes but frequently triangular-dentate and then occasionally longer than the lateral lobes, when developed mostly (0.1)0.2-0.3 (0.5) mm long; lateral lobes often broadly rounded but commonly broadly triangular-dentate and when developed beyond mere undulations then mostly (0.1)0.2-0.4(0.5) mm long; adaxial lobe typically triangular and acute although occasionally rounded, mostly (0.1)0.2-0.6(0.8) mm long. Vexillum about (4.5)6.0-8.0(8.5) mm long and 4.0-6.0 mm wide, broadly obcordate, abruptly to gradually tapering into a narrow, short claw about 1 mm long, entire to erose,



MAPS 8-10. Map 8. *Amorpha glabra.* Map 9. *A. schwerinii.* Map 10. *A. paniculata.*

usually moderately to strongly emarginate, bright reddish-purple. Filaments yellowish to golden, about 8-11 mm long, glabrous; the monadelphous tube noticeably exserted at maturity from the calyx-tube for about (0.5)1.0-2.0 mm, the united portion of the filaments mostly about 3.0-4.5 mm long; anthers about 0.5-1.0 mm long, golden-yellow to orange. Pistil about 7.0-9.0 mm long with a glabrous, obovate ovary about 1 mm high and an antrorsely short-pubescent style terminated by a truncate stigmatic tip. Fruit about (6.5)7.5-9.0(10.5) mm long and (2.5)3.0-

4.0(4.5) mm wide, broadest at or above the middle and tapering to the slender, conical base, glabrous throughout, the upper two-thirds sparsely to moderately covered with small but usually conspicuously pustulate glands, obliquely obovate with the adaxial valve straight or nearly so and the abaxial valve very strongly outwardly bowed above, often terminated by the persistent, 0.2-0.5 mm long base of the style.

Distribution: Endemic to the southern Appalachian Mts. of western N. and S. Carolina, northeastern Ga. and eastern Tennessee. (Map 8.)

The attribution of this species to Arkansas and Oklahoma (Jour. Arnold Arb. **12:** 174-175. 1931, and Proc. Oklahoma Acad. Sci. **27:** 69. 1947.) is, I believe, an error. Specimens so annotated in the past seem to me to be *A. ouachitensis* whose closest relative appears to be the central Texan *A. roermeriana* (=*A. texana*) and not the southern Appalachian endemic.

9. **Amorpha schwerinii** Schneider, Bot. Gaz. 43: 301. 1907. [as *Schwerini*]. TYPIFICATION: **North Carolina:** ROWAN CO., Dunn's Mountain, alt. 1200 ft. *J. K. Small* s.n. (holotype, MO!; isotypes, F! NY!).

   A. densiflora F. E. Boynton ex Small, Fl. SE. U.S. ed. 2. 1342. 1913. TYPIFICATION: **North Carolina:** GASTON CO., slopes of Crowder's Mountain, *Biltmore Herb.* 14756b (lectotype, NY!; isolectotypes, MIN! NY! RM!).

A bushy, widely branched, erect shrub mostly (1)1.5-2.5 m high. Current season's growth dull olive-brown to reddish-brown or dull grayish to almost black and typically slender, about 1.0-2.0 mm in diameter, mostly densely puberulent to curly short-pubescent, usually with a moderate to dense scattering of inconspicuous, small, amber-colored, pustular glands; older branches dark grayish to blackish but becoming dark reddish-brown with numerous, inconspicuous longitudinal fissures and more or less orbicular,

slightly elevated, lenticels, becoming progressively glabrate. Buds globose to ovoid, scales densely puberulent to short-pilose. Leaves wide-spreading, about (0.5)0.8-1.2(2.2) dm long. Petioles mostly (0.7)1.0-1.8(2.6) cm long, mostly equaling or exceeding the length of the lowermost leaflet but occasionally shorter, moderately to densely pubescent with spreading hyaline trichomes (up to 0.7 mm long), bearing none or but few pustular, amber-colored glands. Stipules inconspicuous, usually appressed while present but soon caducous, copiously tawny puberulent to curly short-pubescent externally and glabrous or nearly so within, dark reddish-brown, typically linear to linear-lanceolate, about 3.0-4.5 mm long, eglandular. Rachis of leaves slender, mostly 0.5-0.7 mm in diameter, typically brownish to grayish, moderately to densely puberulent to spreading short-pubescent with the trichomes up to about 0.5 mm long, eglandular or the pustulate glands sparse and inconspicuous. Leaflets mostly (7)19-27(29) in number, usually about (0.5)1.5-3.0(4.0) cm long and (0.4)0.8-1.5(1.9) cm wide, typically about (1.3)2.0-3.0(3.8) times as long as broad, rarely overlapping, the interval between petiolules on the same side of the rachis mostly about (0.6)0.8-1.5(1.8) cm long; usually narrowly to broadly oblong but varying from elliptic to elliptic-oblong and rarely from ovate-oblong to ovate or even almost orbicular in unusual terminal leaflets, typically with the base broadly rounded but varying to somewhat truncate or even slightly subcordate and the apex mostly obtuse to broadly rounded or occasionally emarginate; venation slightly elevated above and more pronouncedly so below. Midvein usually swollen terminally, usually exserted for 0.2-0.5(0.8) mm. Margin entire to very obscurely crenulate and inconspicuously revolute. Lower surface densely pilose with soft ascendant or spreading hyaline, tapering trichomes mostly 0.3-0.6 mm long particularly pubescent along the midvein, moderately to densely beset with olivaceous to amber, punctate glands beneath (about 30-120 glands/half-leaflet); upper surface minutely and obscurely but copiously short-pubescent with hyaline,

appressed to spreading trichomes about 0.1-0.3 mm long. Petiolules usually (0.5)1-2 mm long, densely spreading pilosulose to short-pubescent with hyaline trichomes mostly 0.2-0.6 mm long, indistinctly glandular-pustulate. Stipels acicular, about 1.0-2.2 mm long, often equaling the petiolules in length, typically long-persistent, dark reddish-brown, pilosulose and often densely so at base and glabrous or nearly so above, sparingly pustulate. Racemes 1 or sometimes 2 and the principal one usually terminating strong shoots and the second when present smaller and arising at or near base of the terminal cluster, mostly (2.0)4.0-8.0(12.0) cm long and 1.0-1.5(1.8) cm in diameter; rachis of inflorescence densely pilosulose to short-pubescent, eglandular or nearly so. Pedicels puberulent to pilosulose, eglandular, about (0.8)1.0-1.5(2.0) mm long; bracts caducous, sparingly glandular-pustulate, moderately to densely pilosulose externally and glabrous within, linear to linear-lanceolate, about 2.0-3.5 mm long. Calyx-tube turbinate to obconic-cylindrical, mostly 1.8-2.5 mm long, somewhat asymmetrical with the adaxial side slightly longer than the abaxial, externally sparingly to densely spreading pilosulose throughout, moderately to densely beset with amber-colored, pustulate glands in the upper one-fifth to one-third but eglandular below. Calyx-lobes mostly linear to linear-lanceolate (very rarely the four paired lobes triangular-dentate), acute, sparingly to moderately glandular-punctate, short-pilose both externally and internally, mostly equaling or exceeding the length of the tube. Adaxial lobes about (1.2)2.0-3.0 mm long; lateral lobes about (1.5)2.0-3.2 mm long; abaxial lobe (1.8)2.5-3.5 mm long. Vexillum about 4.5-6.5 mm long, 3.0-4.2 mm wide, very broadly obovate to obcordate, tapering into the slender claw of about 1.5 mm long, apically emarginate and sometimes also inconspicuously apiculate, margin entire to irregularly erose, purplish. Filaments yellowish to golden, about 6-8 mm long, glabrous, united at base into a tube 1.5-2.0 mm long; anthers about 0.5-0.8 mm long, golden-yellow. Pistil about 5-7 mm long with a densely antrorsely pubescent style about 4-6 mm

high and a capitate stigma. Fruit about 5-6.5 mm long and 1.8-2.2 mm wide, tapering to base, usually densely short-pubescent or rarely glabrous or nearly so, usually conspicuously glandular-pustulate in upper half, the adaxial valve straight or nearly so and the abaxial very strongly outwardly bowed above, terminated by the persistent base of the style.

Distribution: River banks and open slopes from the inner North Carolina Piedmont southwest into Alabama. (Map 9.)

This is morphologically one of the most distinctive and clearcut species within the genus.

10. **Amorpha paniculata** T. & G., Fl. N. Am. **1:** 306. 1838.
TYPIFICATION: **Texas:** *T. Drummond* 461 (lectotype, NY!; isolectotype, GH!).

Erect coarse suffrutescent herb or shrub 1-3 m tall and relatively unbranched. Current season's growth usually densely puberulent to spreading short-pubescent or glabrate in age, often somewhat canescent and lacking pustulate glands. Buds obovoid, densely appressed short-pubescent, canescent. Leaves wide-spreading, mostly (1)2-4 dm long. Petioles (2)3-6(9) cm long, usually noticeably longer than the width of the lowermost leaflet, stout, canescent, densely puberulent. Stipules caducous, setaceous, pubescent, about 3 mm long. Rachis of leaf about 2.5 mm in diameter, densely puberulent throughout and more or less canescent. Leaflets drying coriaceous, mostly 11-19, oblong to oblong-elliptic, usually (1.5)3-6(8) cm long and 1.5-3(5.3) cm wide, typically (1.4)1.8-2.2(2.6) times as long as wide, opposite or more commonly alternate, usually symmetrical, typically broadly rounded both apically and basally, conspicuously reticulate below with the veins elevated often to the fourth degree of branching. Midvein exserted up to 1.8 mm or ending at the margin, usually somewhat tapering but rarely swollen. Lower surface usually moderately to densely covered with spreading, crisped, hyaline to tawny, pilosulose trichomes but rarely sparingly to mod-

erately short-pubescent or even glabrate; upper surface glabrate or sparingly short-pubescent to puberulent especially along the principal veins, usually inconspicuously and sparingly to moderately beset beneath with small, pustulate, punctate glands. Petiolules (0.2)0.4-1.0 cm long, moderately to more typically densely spreading pilosulose, somewhat canescent, sparingly and inconspicuously pustulate-glandular. Racemes several to numerous, (1)5-12 in number, about (0.5)1.5-3.0(4.0) dm long; rachis of inflorescence finely pilosulose, canescent. Pedicels slender, about 1-2 mm long, pilosulose; bracts very slender, setaceous, pilosulose, about 2-2.5 mm long. Calyx-tube funnel-form, (1.8)2(2.2) mm long, moderately to densely pilosulose with fine hyaline trichomes or rarely glabrate in age, sparingly to moderately and inconspicuously glandular-pustulate above. Calyx-lobes inconspicuously glandular-pustulate, densely but finely pilosulose; adaxial lobes broadly to narrowly triangular-dentate or ovate, acute, 0.8-1.0(1.2) mm long; lateral lobes longer and usually more narrowly lanceolate, acute to acuminate, (1.0)1.2-1.4 mm long; abaxial lobe (1.2)1.5-2.0 mm long, linear to linear-lanceolate. Vexillum 5-7 mm long, 3-4 mm wide, entire to slightly erose apically, purple. Filaments about 5-6 mm long, united for about half their length, glabrous; anthers about 0.6-0.8 mm long, orange. Style densely villous; ovary glabrous. Fruit 4-6(8) mm long and 2-2.5 mm wide, broadest somewhat above the middle, tapering to the base, with the adaxial margin strongly outwardly bent in the upper quarter and the abaxial margin strongly outwardly bowed, glabrous, conspicuously glandular-pustulate. Seed reddish-brown, about 3.5 mm long and 1.8 mm wide, smooth.

Distribution: Thickets, bogs, swampy woods and ditches of southwestern Arkansas, west central Louisiana and eastern Texas. (Map 10.)

The distinctiveness and relative uniformity of this species is suggested by its lack of synonyms. The only synonym sometimes associated with it has been *A. roemeriana*

Scheele, but I believe this binomial properly belongs to the central Texan plant previously referred to as *A. texana* Buckl.

11. **Amorpha nitens** Boynton, Biltmore Bot. Stud. **1**: 139. 1902. TYPIFICATION: **Georgia:** swamp near Waynesboro, *Biltmore Herbarium* s.n. (holotype: not seen, designated as at the Biltmore Herbarium and hence presumably at the US).

A. nitens var. *leucodermis* E. J. Palmer, Jour. Arnold Arb. **12**: 177. 1931. TYPIFICATION: **Georgia:** thicket along lake, Augusta, *Boynton* 7035 (holotype, GH!).

An erect, branching shrub 1-3 m tall. Current season's growth usually blackening or at least darkening upon drying, glabrous to sparingly or even moderately puberulent to pilosulose, usually eglandular or bearing only a few scattered, small inconspicuous glands. Buds compressed and broadly oblong or ovoid, blackish when dried, sparingly pilosulose to glabrate except for the shortly puberulent margins of the outer scales. Leaves more or less widespreading to ascendant, mostly 1-1.8(2.2) dm long, usually conspicuously darkening or blackening upon drying. Petioles glabrous to moderately crispy short-pilose, eglandular or with a few, inconspicuous, small, pustulate glands, typically longer than the width of the lowermost leaflet, mostly (1.5)2-3.5(5) cm long. Stipules caducous, linear to linear-setaceous, eglandular, drying blackish, usually glabrous except externally with an apical tuft of tawny pubescence, mostly 3-5 mm long. Rachis of leaf about 0.6-1.0 mm in diameter, glabrous to moderately crispy-pilosulose, usually eglandular but rarely very sparingly and inconspicuously glandular. Leaflets (7)9-15(19) in number, oblong to elliptic-oblong or occasionally somewhat ovate, mostly 2-4(7) cm long and (1.0)1.5-3.5(4.5) cm wide, typically 1.5-2.5 times as long as wide, opposite or more typically alternate, usually widely spaced, symmetrical, usually broadly

rounded basally, apically obtuse to more typically broadly rounded and often emarginate, entire; secondary venation usually little, if at all, elevated beneath. Midvein typically shortly exserted and but little tapered. Lower surface of leaflets glabrous to moderately spreading pilosulose throughout or the pubescence sometimes restricted to the midvein, eglandular or inconspicuously and often rather sparingly beset with small punctate glands; upper surface eglandular and glabrous and often shiny at maturity but occasionally sparsely beset with extremely minute and fine, appressed short-pubescence. Petiolules about 2-3.2 mm long, glabrous to moderately spreading pilosulose, eglandular to inconspicuously and very sparingly pustulate glandular. Racemes erect, solitary or with several clustered together, (0.5)0.8-1.5(2.5) dm long; rachis of inflorescence glabrous to moderately pilosulose or puberulent, eglandular or very sparingly and inconspicuously pustulate-glandular. Pedicels 1-2.2 mm long, glabrous to moderately pilosulose or crispy pubescent, slender, eglandular, blackening upon drying; bracts usually caducous, basally attached on pedicel or distally as much as midway towards the tip, very narrowly linear to setaceous, 1.5-3(4) mm long, glabrous to externally tangled tawny-pilosulose especially along the margins, usually eglandular but occasionally inconspicuously and very sparingly pustulate glandular, typically blackening upon drying. Calyx-tube slenderly obconic to broadly funnelform to rarely even roundedly campanulate, mostly 2-2.5 mm long, glabrous to moderately pilosulose, often completely eglandular but occasionally very sparingly beset with inconspicuous, minute pustular glands in the upper third. Calyx-lobes with a ciliate fringe and with the outer surface glabrous to pilosulose, eglandular; adaxial calyx-lobes usually broadly rounded and obtuse but occasionally varying to triangular, and acute, about 0.2-0.6 mm long; lateral calyx-lobes broadly rounded to more typically triangular, about 0.4-1.0 mm long; abaxial lobe triangular and acute and often narrowly so, 0.6-1.4 mm long. Vexillum 4.5-6 mm long, 3-4.8 mm wide, broadly obovate, grad-

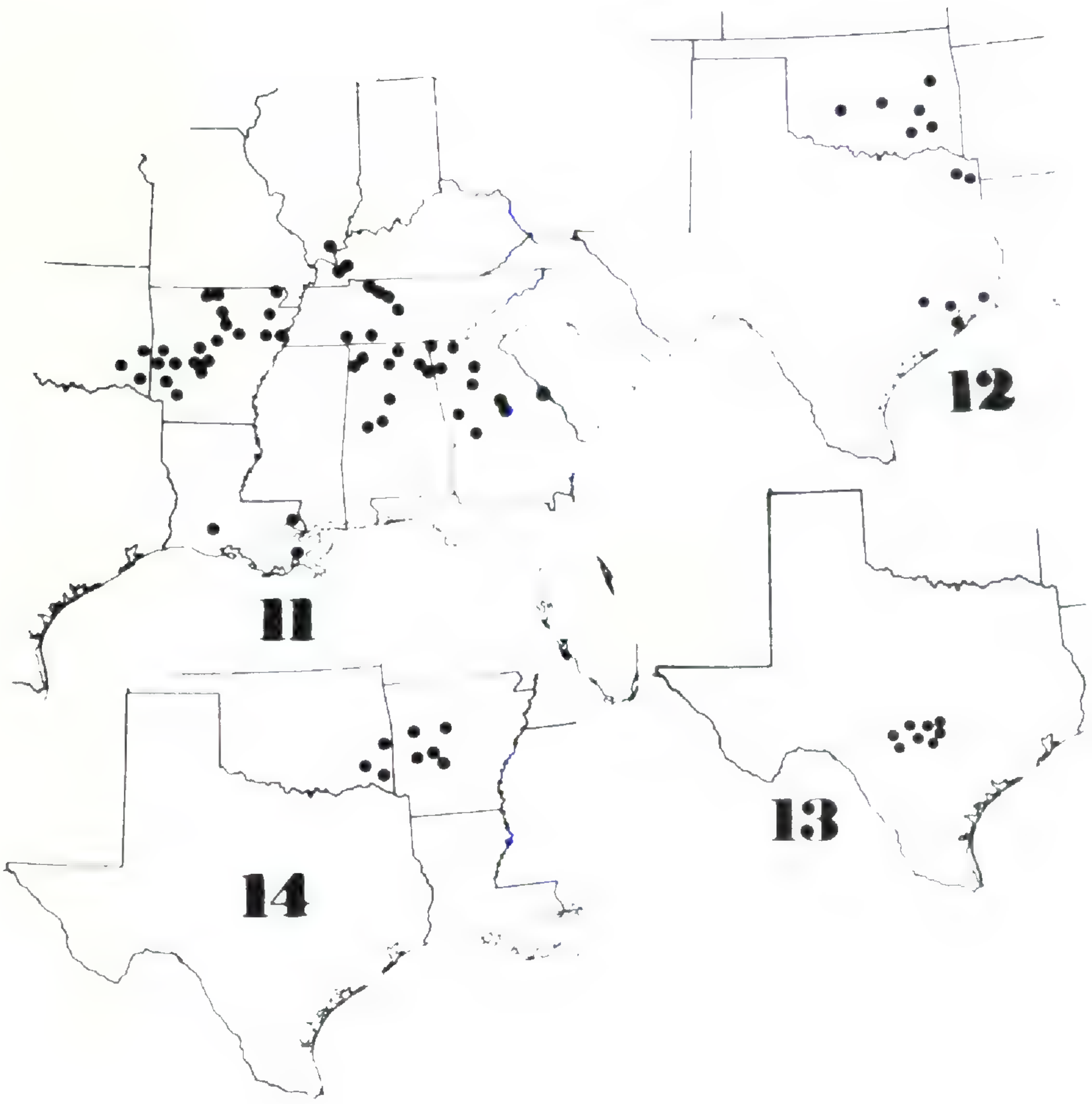
ually tapering into an indistinct claw about 1-1.5 mm long, slightly to strongly arched, apically broadly rounded and entire to irregularly erose, apparently reddish purple ["blue-purple *fide* Palmer"] and with the claw and blade both enveloping the filaments. Filaments 5-7 mm long, united into a sheath for the lower 2-2.5 mm, glabrous; anthers 0.5-0.8 mm long, yellow. Style moderately ascendingly pilose, 5-7 mm long; ovary glabrous. Fruit 6-8 mm long and 2.5-3.5 mm wide, broadest above the middle and tapering basally with the adaxial suture straight or slightly curved and the abaxial strongly outwardly bowed, glabrous, moderately pustulate glandular distally. Seeds smooth, dark reddish-brown to blackish, 3-4.2 mm long.

Distribution. Thickets and moist woods along creeks, rivers and bottomlands from southern Illinois southeast into Georgia and west into Louisiana and eastern Oklahoma. (Map 11.)

12. **Amorpha laevigata** Nutt. in Torr. & Gray, Fl. N. Am. 1: 306. 1838. TYPIFICATION: "Banks of the Arkansas, near Salt River," *Nuttall* s.n. (holotype, BM, not seen; phototype: A!)

A. laevigata var. *typica* Schneider, Illustr. Handb. Laubh. 2: 74. 1907.

Shrub 1-2(3) m tall. Current season's growth sparingly to moderately strigillose and glandular-pustulate, light brown to more characteristically deep reddish-purple. Buds suborbicular to ovoid, compressed; the scales sparingly short-pubescent. Leaves wide-spreading to moderately ascendant, mostly (0.5)0.8-1.5(2.4) dm long. Petioles (0.6)1.0-2.5(3.4) cm long, about 1 mm in diameter, very sparingly strigillose or glabrous, sparingly to moderately glandular-pustulate, usually longer than the width of the lowermost leaflet. Stipules caducous, linear-subulate to setaceous, glabrous, dark reddish-purple, about 2-3 mm long. Rachis of leaf 0.5-1 mm in diameter, glabrous or very sparingly



MAPS 11-14. Map 11. *Amorpha nitens.* Map 12. *A. laevigata.* Map 13. *A. roemeriana.* Map. 14. *A. ouachitensis.*

strigillose, sparingly to moderately glandular-pustulate. Leaflets (9)13-19(25), oblong or oblong-elliptic to rarely obovate, usually (1.0)1.6-3.2(4.2) cm long and (0.4)1.0-1.5(2.2) cm wide, typically (1.5)1.8-2.4(2.8) times as long as wide, usually alternate and symmetrical, characteristically basally rounded but rarely acutely tapering, apically usually broadly rounded and often emarginate; venation little elevated beneath except for the midvein; margin entire to slightly crenulate. Midvein either exserted as a blunt or slightly tapering mucro or more characteristically terminating in a swollen knob exserted not more than 0.2

mm. Lower surface glabrous or very sparingly strigillose especially along the midvein, moderately to densely beset with conspicuous punctate glands often appearing to be of two size classes or rarely nearly epunctate; upper surface glabrous. Petiolules (1)2-3(4) mm long, glabrous or more typically sparingly to moderately strigillose, conspicuously and densely beset with markedly elevated pustulate glands; stipels usually persisting, dark reddish or blackish, about 1-2 mm long. Racemes solitary or loosely clustered, 1-3(8), about (0.5)1.0-2.0(3.0) dm long; rachis of inflorescence very sparingly strigillose, eglandular or sparingly glandular-pustulate. Pedicels usually 0.6-1.2 mm long and sparingly to moderately strigillose, eglandular; bracts caducous, setaceous to narrowly lanceolate with a long-tapering apex, sparingly to moderately strigillose, 1.5-3 mm long, glandular-pustulate. Calyx-tube funnelform to somewhat campanulate, about 1.5-3 mm high, glabrous or sparingly to moderately strigillose, moderately to more typically densely beset with pustulate glands in upper two-thirds. Calyx-lobes sparingly to densely strigillose with a dense fringe of white trichomes, glandular-pustulate; adaxial lobes broadly rounded to triangular-dentate and acute, about 0.2-0.5 mm long; lateral lobes usually triangular dentate and acute to acuminate but occasionally broadly rounded, 0.5-0.8 mm long; adaxial lobe narrowly triangular-dentate, 0.8-1.2 mm long. Vexillum about 4-6 mm long and about 4.0-4.5 mm wide, entire to finely erose, bright blue to deep violet blue. Filaments to 9 mm long, united for about half their length, glabrous; anthers about 0.5-0.7 mm long, orange. Ovary glabrous; style antrorsely pubescent. Fruit about 4.5-6 mm long and 2-2.5 mm wide, with the adaxial suture straight or slightly incurved near the apex and the abaxial suture strongly outwardly bowed, glabrous or rarely sparingly strigillose, conspicuously glandular-pustulate on the distal three-fourths.

Distribution: A rare species of prairies, open woods and creek banks of eastern Texas and Oklahoma. (Map 12.)

13. **Amorpha roemeriana** Scheele, Linnaea **21**: 461. 1848. TYPIFICATION: "In margine rivulorum prope, Austin," *F. Roemer* s.n. (holotype: not seen by me or by anyone else who has commented upon it.)

A. fruticosa var. [1] *subglabra* A. Gray, Boston Jour. Nat. Hist. **6**: 174. 1850. TYPIFICATION: **Texas:** on a creek near Fredericksburg, June 1847, *Lindheimer* s.n. (holotype, GH!). It is doubtful if Gray intended or actually did publish this varietal name. The type-style is different than that employed in this paper for varieties and its punctuation is also different. The next entry in the Plantae Lindheimerianae is also listed by Gray as *A. fruticosa* var. *subglabra*.

A. laevigata var. *pubescens* A. Gray, Smithsonian Contr. Knowledge **3**: 49. 1852. TYPIFICATION: "Eastern" Texas, *Charles Wright* s.n. (holotype, GH!).

A. texana Buckley, Proc. Acad. Nat. Sci. Philadelphia **1861**: 452. 1862. TYPIFICATION: **Texas:** "On the Pierdenalis River," *S. B. Buckley* s.n. (holotype, PHIL!).

A. subglabra (A. Gray) Heller, Contr. Herb. Franklin & Marshall Coll. **1**: 48. 1895.

A. texana [var.] *mollis* Boynton, Biltmore Bot. Stud. **1**: 139. 1902. A needlessly created "*nom. nov.*" based on "*A. laevigata pubescens* A. Gray."

A. laevigata var. *pubescens* f. *mollis* (Boynton) C. K. Schneider, Bot. Gaz. **43**: 307. 1907.

A. texana var. *glabrescens* E. J. Palmer, Jour. Arnold Arb. **12**: 180. 1931. TYPIFICATION: **Texas:** [COMAL CO.] Comanche Spring; New Braunfels etc., *Lindheimer* 743 (holotype, A!; isotypes, ARIZ!, F!, GH!, MO!, NY!, OKL!, PHIL!, UC!, US!).

Shrub 1-3 m tall. Current season's growth sparingly to densely puberulent or strigillose or rarely glabrous, occa-

sionally glabrate in age, sparingly to moderately glandular-pustulate. Buds ovoid, compressed, the scales often somewhat keeled, sparingly to moderately puberulent. Leaves strongly divergent, (0.5)1-1.5(2) dm long. Petioles (0.5)1.5-3.0 cm long, about 1 mm in diameter, very sparingly to occasionally densely puberulent or strigillose, sparingly to moderately glandular-pustulate, usually equaling or longer than the width of the lowermost leaflet. Stipules caducous and rarely seen, linear, tawny puberulent, ca. 2 mm long. Rachis of leaf slender, 1-1.6 mm in diameter or less, very sparingly to moderately strigillose or puberulent or rarely densely puberulent. Leaflets (7)9-11(15), oblong or more typically broadly oblong to oblong-elliptic or rarely obovate to suborbicular, usually (1.0)2.5-4.0(5.2) cm long and (0.7)1.5-2.5(3.8) cm wide, typically (1.0)1.3-2.9(3.0) times as long as wide, opposite or more commonly alternate, typically symmetrical, usually broadly rounded basally and apically either broadly rounded or more characteristically emarginate and often conspicuously so; venation little elevated beneath other than the midvein and to a slight degree the secondary veins; margins entire to conspicuously crenulate. Midvein rarely exserted as much as 0.8 mm long as a tapering mucro but more typically terminating in a slightly swollen knob at the margin or tapering less than 0.2 mm beyond. Lower surface usually sparingly to moderately pilosulose or puberulent with fine, hyaline trichomes or rarely glabrous or nearly so, usually inconspicuously and moderately beset with small punctate glands; upper surface glabrous or at least glabrate to moderately pilosulose or finely puberulent especially along the principal veins. Petiolules usually 2-5(7) mm long, glabrous to densely puberulent or pilosulose, often becoming wrinkled upon drying, usually sparingly to moderately glandular-pustulate but rarely eglandular. Stipels inconspicuous, often caducous, dark reddish, about 1.2-2 mm long. Racemes solitary or loosely clustered, 1-3(6) in number, about (4)6-12(20) cm long; rachis usually sparingly to moderately strigillose or puberulent, rarely densely tawny or

hyaline puberulent or short-pubescent, sparingly glandular-pustulate; pedicels mostly 1-1.5 mm long, usually sparingly to moderately puberulent or strigillose; bracts caducous, setaceous to narrowly lanceolate and then often with a long-tapering apex, puberulent or pilosulose, 1.2-2.2 mm long. Calyx-tube funnelform, usually 2.5-3.8 mm long, very sparingly to moderately strigillose to pilosulose with hyaline trichomes, moderately glandular-pustulate in upper third; lobes moderately to more characteristically densely short-pubescent above with a conspicuous fringe of white trichomes, glandular-pustulate; adaxial lobes broadly rounded to broadly triangular-dentate and acute, (0.2) 0.4-0.6(0.8) mm long; lateral lobes broadly rounded to more characteristically acutely triangular-dentate, 0.5-0.8(1.0) mm long; abaxial lobe usually narrowly triangular-dentate, about (0.8)1.0-1.2(1.4) mm long. Vexillum about 5-7 mm long, 5-6 mm wide, emarginate and occasionally apiculate, entire to slightly erose, purple. Filaments at maturity to 10 mm long, united for up to two-thirds their length, glabrous; anthers about 0.6-0.8 mm long. Style villous; ovary glabrous. Fruit about 6-7 mm long and 2.5-3.5 mm wide, plump at maturity, with the adaxial margin straight or somewhat inwardly bent in the upper third and the abaxial margin strongly outwardly bowed, glabrous to moderately strigillose, conspicuously glandular-pustulate above. Seed bright brown, about 3 mm long and 2 mm wide.

Distribution: All creek bed and stream banks of the "Hill Country" of central Texas in the eastern portion of the Edwards Plateau. (Map 13.)

There is no record in the literature that anyone has examined authentic material of *A. roemeriana* Scheele. A. Gray stated (Boston Jour. Nat. Hist. **6:** 175. 1850.) that *A. roemeriana* was "doubtless a form of *A. fruticosa* or of *A. paniculata.*" Later Gray (Proc. Acad. Nat. Sci. Phil. **1862:** 162) indicated that *A. roemeriana* was apparently the same as *A. texana* Buckl. which he synonymized with *A. laevigata* var. *pubescens.* Watson (Smithsonian Misc.

Coll. 258. 188. 1878), Schneider (Bot. Gaz. 43: 307. 1907) Rydberg (N. Am. Fl. 24: 27. 1919) and Palmer (Jour. Arnold Arb. 12: 179. 1931) have all listed Scheele's *A. roemeriana* as a synonym of *A. paniculata* T. & G.

Unfortunately for the sake of stability, it would seem most unlikely that *A. roemeriana* can be considered a synonym of *A. paniculata*. *A. paniculata* is a largely East Texas species of thickets and low swampy or marshy ground. *A. roemeriana* was originally collected along a creek bend near Austin which is its eastern range limit. *Amorpha texana* has been collected in Travis Co. while *A. paniculata* is not known from the vicinity. The original description itself is far more suggestive of the central Texan species than it is of more easternly ranging *A. paniculata*. I have no doubt that *A. roemeriana* is an earlier name for the species recently known as *A. texana*.

Palmer (1931) recognized a glabrous or subglabrate and a spreading pubescent variety of this species. There seems to be no geographic segregation of these pubescence types and actually there seems to be as much of a continuum in vestiture as one could expect in so small a number of collections as are available of this species. I concur with Turner (The Legumes of Texas, p. 143, 1959) and Correll and Johnston (Man. Vasc. Pl. Tex., p. 818, 1970) who did not recognize the varieties either. Both of these taxonomic works suggest that *A. laevigata* is not specifically distinct from *A. texana*, Turner suggesting that *A. laevigata* "perhaps is best treated as a narrow-leaved eastern variety of *A. texana*" while Correll and Johnston indicated that it was "perhaps only a form of *A. texana*." I believe the differences in petal color, calyx shape, texture and glandularity etc. all indicate considerable morphological divergence between the two taxa.

14. **Amorpha ouachitensis** Wilbur, sp. nov. TYPIFICATION: **Oklahoma:** LE FLORE CO., dry, rocky (sandstone) slopes of Black Fork Mountain, near Page, *Palmer* 20572 (holotype, A!; isotypes, GA!, NY!, US!).

Frutex erectus 1-2 m altus. *Foliola* (7)9-13(17), lateralia oblonga vel oblongo-elliptica, opposita, basi et apice rotundata vel emarginata, (1.2)2.5-4.0(7.0) cm longa et (0.9)1.5-2.5(3.6) cm lata. *Tubus calycis* 2.8-3.2 mm altus, ± glaber, glanduloso-punctatus in quarta parte superiore. *Lobi calycis* glabri vel pubescentes; lobi abaxiales 0.4-0.6 mm longi; lobi laterales 0.5-0.7 mm longi; lobi adaxiales 0.6-0.9 (1.2) mm longi. *Vexillum* 5-7.5 mm longum, rubicundo-purpureum.

Shrub 1-2 m tall. Current season's growth glabrous or more typically very sparingly to moderately pilosulose and sparingly pustulate glandular with inconspicuous lenticular glands. Buds ovoid to almost globose with the scales moderately appressed pubescent on the outer surface and apically densely ciliate with tawny-villous trichomes. Leaves strongly divergent, 7-23 cm long. Petioles 1.2-2(2.4) cm long and about 0.5-1.5(2) mm in diameter, moderately puberulent or short-pilose with hyaline to tawny trichomes, sparingly to moderately glandular-pustulate, usually equalling or longer than the width of the lowermost leaflet. Stipules caducous, lanceolate, densely tawny villous apically, ca. 3-4 mm long including the apical tuft but only about 2 mm long excluding the apical villosity. Rachis of leaf mostly 1 mm in diameter or less, very sparingly pilosulose to even glabrous, sparingly glandular-pustulate. Leaflets (7)9-13(17), typically broadly oblong to oblong-elliptic or oblong, mostly (1.2)2.5-4.0(7.0) cm long and (0.9)1.5-2.5(3.6) cm wide, typically (1.4)1.5-2(2.4) times as long as wide, usually opposite, typically symmetrical, usually broadly rounded basally and apically characteristically conspicuously emarginate to broadly rounded; venation but little elevated beneath other than the midvein; margins entire to inconspicuously undulate-crenate. Midvein exserted either as a tapering mucro about 0.2-0.6(1.0) mm or only slightly exserted and terminating in a swollen knob. Lower surface of the leaflets glabrous or

glabrate to sparingly or even moderately appressed pilosulose or less commonly spreading pilosulose or short pubescent with fine, hyaline to pale tawny, slender trichomes and usually conspicuously beset with numerous pustulate, amber-colored glands; upper surface glabrous or glabrate to moderately pilosulose with inconspicuous, slender trichomes and lacking pustulate glands. Petiolules mostly 2-3 (4) mm long, glabrous or glabrate to moderately short-pubescent or pilosulose, sparingly to moderately glandular-pustulate or rarely eglandular. Stipels inconspicuous, sometimes caducous, drying dull dark reddish-brown, mostly 1.2-2.2 mm long, glabrous or sparingly appressed pilosulose. Racemes solitary or in loose clusters of 2-4, mostly (8) 10-20 cm long; rachis of inflorescence glabrous to sparingly or even moderately spreading short-pubescent with hyaline or very rarely tawny trichomes and eglandular or very sparingly and inconspicuously pustulate-glandular; pedicels about 1-1.5 mm long, glabrous to sparingly puberulent; bracts caducous, narrowly lance-oblong, about 1-1.5 mm long, marginally short-pubescent with stiff, hyaline trichomes. Calyx-tube narrowly conical to funnelform, about 2.8-3.2 mm long, usually glabrous or nearly so to moderately puberulent or spreading short-pubescent, sparingly glandular pustulate in the upper quarter; lobes usually glabrous but occasionally moderately appressed pubescent on the external surface and densely margined with a conspicuous fringe of white trichomes, eglandular to sparingly pustulate glandular; adaxial lobes broadly rounded, mostly 0.4-0.6 mm long; lateral lobes broadly rounded or perhaps more characteristically broadly triangular-dentate, about 0.5-0.7 mm long; abaxial lobe narrowly triangular-dentate with an acute to acuminate apex, about 0.6-0.9(1.2) mm long. Vexillum about 5-7.5 mm long and 4.5-6 mm wide, strongly emarginate but otherwise entire, purple. Filaments at maturity 8-10 mm long, united for up to 3/5 their length, glabrous; anthers about 0.6-0.8 mm long. Style antrorsely pilosulose; ovary usually glabrous. Fruit about 7-9 mm long and 3-4 mm wide and with the adaxial margin

either straight or more typically mostly straight but with the upper portion bent sharply abaxially and the abaxial margin strongly outwardly bowed, glabrous or occasionally somewhat appressed, short-pubescent and conspicuously pustulate-glandular. Seed solitary, dark brownish to blackish, about 4-5 mm long and 2.5-3 mm wide.

Distribution: Ouachita Mountains of west-central Arkansas and southeastern Oklahoma. (Map 14.)

This species has previously been included within the concept of other species. Palmer cited specimens of it as *A. glabra* Poir. (Jour. Arnold Arb. **12:** 175. 1931) and also *A. virgata* (Jour. Arnold Arb. **12:** 182. 1931) which I have treated as a synonym of *A. fruticosa*. *Amorpha glabra* is in my opinion a southern Appalachian endemic while the range of *A. fruticosa s.lat.* spans the continent. I believe the morphology of *A. ouachitensis* indicates a closer relationship with the rare central Texan endemic *A. roemeriana* (= *A. texana*) than with either *A. glabra* or *A. fruticosa*.

Representative Specimens: **Arkansas:** CONWAY CO., rocky mountainsides, Petit Jean Mt., *Demaree* 37161 (SMU); GARLAND CO., shale outcrop on banks of Ouachita River near Hot Springs, *Palmer* 24252 (A); LOGAN CO., rocky glades, top of Magazine Mt., *Palmer* 24187 (A, MO, UARK); MONTGOMERY CO., Mount Ida, open banks of Ouachita River below bridge, *Demaree* 37965 (SMU); POLK CO., Rich Mt., rich woods E of lodge near Lover's Leap, *Tucker* 12285 (DUKE). **Oklahoma:** LE FLORE CO., Ouachita National Forest, *Goodman* 2545 (GH, ISC, MO, NY, OKL), rocky slopes of Blackfort Mt., near Page, *Palmer* 20913 (A); MCCURTAIN CO.: rocky sandy soil in woods 37 mi. N of Broken Bow, *Stratton* 1146 (OKL); PUSHMATAHA CO., rocky stream bank, 4 mi. W of Albion, *Stratton* 4161 (LL, OKL).

15. **Amorpha fruticosa** L., Sp. Pl. 2: 713. 1753.

A. fruticosa α *vulgaris* Pursh, Fl. Am. Sept. 2: 466. 1814.

A. fruticosa β *emarginata* Pursh, Fl. Am. Sept. 2: 466. 1814.

A. fruticosa γ *angustifolia* Pursh, Fl. Am. Sept. 2: 466. 1814.

A. croceolanata Wats., Dendr. Brit. 2: *t. 139.* 1825 [as *crocealanata*].

A. emarginata (Pursh) Sweet, Hort. Brit. 121. 1827.

A. fragrans Sweet, Brit. Fl. Gard. 3: *t. 241.* 1828.

A. caroliniana Croom, Amer. Jour. Sci. 25: 74. 1834. TYPIFICATION: **North Carolina:** near New Bern, *Loomis* s.n. (lectotype, NY!).

A. fruticosa var. 5 *coerulea* Loudon, Arb. Brit. 607. 1838.

A. humilis Tausch, Flora 21: 750. 1838. TYPIFICATION: undetermined; based on cultivated plants grown in Prague.

A. fruticosa var. 4 *Lewisii* Loudon, Arb. Brit. 2: 607. 1838.

A. tennessensis Shuttleworth ex Kunze in Delect. Sem. Hort. Lips. 1848: 1. 1848; Linnaea 24: 191. 1851. TYPIFICATION: **Tennessee:** Ad rivulos prope Dandridge, *Rugel* s.n., June 1842 (isolectotype, GH!).

A. fruticosa var. *caroliniana* (Croom) S. Wats., Smithsonian Misc. Coll. 258. 188. 1878.

A. fruticosa var. *crispa* Kirchn., Arb. Musc. 370. 1864.

A. pendula Carr., Rev. Hort. 1870-71: 378.

A. fruticosa var. *pendula* (Carr.) Dipp., Laubh. 3: 691. 1893.

A. fruticosa f. *albiflora* Sheldon, Bull. Geol. & Nat. Hist. Surv. Minnesota 9: 72. 1894. TYPIFICATION: **Minnesota:** MILLE LACS CO., on the banks of the Rum River, 3 miles north of Milaca, *Sheldon* s.n. (holotype, MIN!).

A. virgata Small, Bull. Torrey Club 21: 17. *pl. 171.* 1894. TYPIFICATION: **Georgia:** DE KALB CO., NW. slope of Stone Mountain, alt. 1000-1400 ft., *Small* s.n., 3 July 1893 (lectotype, NY!; isolectotypes, GA!, GH!, ISC!, MIN!, MO!, UC!, US!).

A. fruticosa var. *croceolanata* (Wats.) Mouillefort, Arb. Arbriss. 1: 577. 1894.

A. angustifolia (Pursh) Boynton, Biltmore Bot. Stud. **1**: 139. 1902.

A. fruticosa f. *aureo-variegata* Schwerin, Mitteil. Deutsch Dendr. Ges. **16**: 255. 1907.

A. fruticosa var. *typica* Schneider, Bot. Gaz. 43: 304. 1907.

A. fruticosa f. *crispa* (Kirchn.) C. K. Schneider, Illustr. Hand. Laubh. **2**: 72. 1907.

A. fruticosa f. *pendula* (Carr.) C. K. Schneider, Illustr. Handb. Laubh. **2**: 73. 1907.

A. fruticosa var. *humilis* (Tausch) Schneider, Bot. Gaz. 43: 305. 1907.

A. occidentalis Abrams, N. Y. Bot. Gard. Bull. **6**: 394. 1910. TYPIFICATION: **California:** San Diego River, near Old San Diego Mission, *Abrams* 3425 (holotype, DS, not seen; isotypes, A!, DS!, GH!, MO!, NY!, POM!, UC!, US!)

A. Bushii Rydb., N. Am. Fl. **24**: 31. 1919. TYPIFICATION: **Florida:** uncommon near spring, Chattahoochee River, *Bush* 13 (holotype, NY!; isotype: A!)

A. Curtissii Rydb., N. Am. Fl. **24**: 30. 1919. TYPIFICATION: **Florida:** DUVAL CO., low ground near river, Jacksonville, *Curtiss* 4703 (holotype, NY!; isotypes, KANU!, US!)

A. arizonica Rydb., N. Am. Fl. **24**: 33. 1919. TYPIFICATION: **Arizona:** COCHISE CO., along streams, Ramsey Canyon, Huachuca Mountains, *Gooding* 136 (holotype, NY!; isotypes: ARIZ!, GH!, NEB!, NY!, RM!, UC!).

A. occidentalis var. *arizonica* (Rydb.) E. J. Palmer, Jour. Arnold Arb. **12**: 185. 1931.

A. fruticosa f. *humilis* (Tausch) E. J. Palmer, Jour. Arnold Arb. **12**: 189. 1931.

A. fruticosa f. *coerulea* (Loud.) E. J. Palmer, Jour. Arnold Arb. **12**: 189. 1931.

A. fruticosa var. *angustifolia* f. *glabrata* E. J. Palmer, Jour. Arnold Arb. **12:** 191. 1931. TYPIFICATION: **Texas:** BRAZOS CO., shores of lake, Kurten, *Palmer* 13479 (holotype: A!; isotype, MO!).

A. fruticosa var. *tennesseensis* (Shuttleworth ex Kunze) E. J. Palmer, Jour. Arnold Arb. **12:** 192. 1931.

A. fruticosa var. *oblongifolia* E. J. Palmer, Jour. Arnold Arb. **12:** 192. 1931. TYPIFICATION: **Arkansas:** PHILLIPS CO., low alluvial ground, along Mississippi River, near Helena, *Palmer* 26628 (holotype, A!; isotypes, DS!, MO!, UARK!).

A. occidentalis var. *emarginata* E. J. Palmer, Jour. Arnold Arb. **12:** 185. 1931. TYPIFICATION: **Arizona:** [MARICOPA CO.] Fish Creek, Apache Trail, *Eastwood* 8745 (holotype, A!; isotype, CAS!).

A. emarginata Eastwood, Proc. Calif. Acad. Sci. **20:** 148. 1931, not *A. emarginata* (Pursh) Sweet, 1827. TYPIFICATION: **Arizona:** [MARICOPA CO.] Fish Creek, Apache Trail, *Eastwood* 8745 (holotype, CAS!; isotype: A!).

A. DeWinkeleri Small, Man. Se. Fl. 689. 1933. TYPIFICATION: **Florida:** LEE CO., prairies near Ft. Shackleford, Big Cypress, *Small* 8349 (lectotype, NY!; isolectotypes, GH!, MO!, US!).

A. fruticosa var. *augustifolia* f. *latior* Fassett, Rhodora **38:** 190. 1936. TYPIFICATION: **Wisconsin:** ST. CROIX CO., stony shore of Lake St. Croix, 10 miles south of Hudson, *Fassett* 17014 (holotype, WIS, not seen; isotypes, GH!, MO!, NY!).

A. fruticosa var. *occidentalis* (Abrams) Kearney & Peebles, Jour. Washington Acad. Sci. **29:** 483. 1939.

An erect shrub (1)2-3(4) m tall with one to several stems arising from the base and often branching above sufficiently so as to appear bush-topped. Current season's growth rarely glabrous or densely to moderately pilosulose

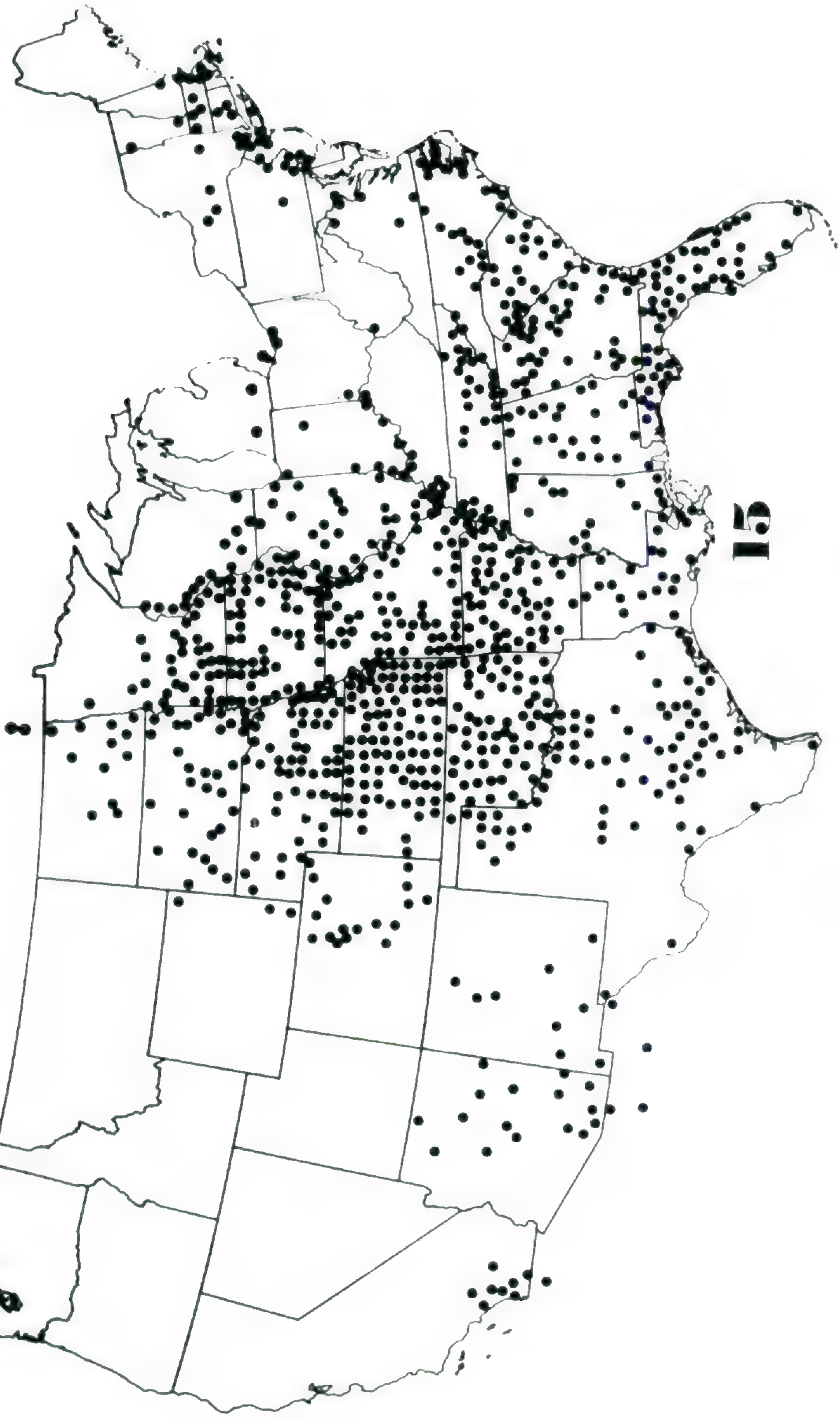
to puberulent or strigillose, occasionally becoming glabrate; eglandular or very sparingly and inconspicuously pustulate-glandular, grayish to dark reddish-brown, occasionally somewhat glaucescent. Buds ovoid to subglobose, light brownish to dark reddish-brown, usually more or less glabrous except for the ciliate margins of the scales or occasionally pilosulose. Leaves wide-spreading to somewhat ascendant, mostly 1-2.8 dm long, usually remaining green but occasionally turning brownish upon drying but not blackening. Petioles moderately puberulent to crispy pilosulose and often becoming glabrate, rarely glabrous, eglandular or sparingly pustulate with small, inconspicuous glands, typically longer than the width of lowermost leaflet, mostly 1-4 cm long. Stipules caducous, narrowly linear, eglandular or very sparingly and inconspicuously pustulate, reddish-brown, externally and especially apically tawny to hyaline pilosulose, usually 2-4 mm long. Rachis of leaf about 0.5-1 mm in diameter, rarely glabrous or more typically sparingly to densely puberulent to crispy pilosulose or glabrate, eglandular or very sparingly and inconspicuously pustulate-glandular. Leaflets 9-21(31), oblong to elliptic-oblong or elliptic or even occasionally ovate, (1)2-4(5) cm long and (0.5)1-2(2.7) cm wide, mostly 2-3(6) times as long as wide, usually opposite or subopposite, basally symmetrical or rarely asymmetrical, acute to broadly rounded basally, rounded to acute or rarely emarginate apically, entire or nearly so; secondary venation moderately elevated beneath. Midvein usually slender, exserted, about 0.5-1.5 mm long and tapering, but occasionally only very shortly exserted and little, if at all, tapering. Lower surface of leaflets sparsely to densely spreading puberulent to crispy pilosulose (occasionally so densely so as to appear velvety) when young or rarely either glabrous or sometimes glabrate in fruit, often strigose or strigillose or occasionally even short-spiculate with the trichomes either hyaline, or ashy or even tawny; eglandular or inconspicuously beset with small pustulate glands or very rarely rather conspicuously glandular-punctate; upper surface

usually very short-puberulent to glabrous when young and typically glabrate when mature but occasionally densely pilosulose, eglandular. Petiolules about (1.5)2-4 mm long, sparingly to densely puberulent or more typically spreading pilosulose, occasionally becoming glabrate, or very rarely glabrous, usually inconspicuously pustulate-glandular. Stipels slenderly cylindric, setaceous mostly 2-4 mm long, glabrous to moderately puberulent. Racemes erect, solitary or more typically with several to many clustered together, usually densely flowered, (0.5)1-2(2.5) dm long; rachis of inflorescence usually moderately to densely puberulent or pilosulose, sometimes becoming glabrate in age, eglandular or very sparingly and inconspicuously pustulate-glandular. Pedicels mostly 1-2.2 mm long, sparsely to densely spreading puberulent or more typically crispy pilosulose or short-spiculate or even glabrous, eglandular or very sparingly and inconspicuously pustulate-glandular; bracts caducous, borne basally on the pedicels, very narrowly linear to setaceous, mostly 1.5-3 mm long, sparingly to densely pilosulose externally, usually eglandular, typically dull reddish-brown. Calyx-tube usually obconic but varying to funnelform or even somewhat campanulate, mostly 2-3(4) mm long, glabrous or spiculate, or sparingly to densely puberulent or pilosulose, sparsely to moderately pustulate-glandular on the upper third of tube with small and inconspicuous to large and conspicuous amber-colored glands but occasionally eglandular; lobes with a hyaline, ciliate-fringed margin and with the external surface sparingly to moderately pilosulose and either eglandular or very sparingly beset with inconspicuous pustulate glands; adaxial lobes broadly rounded to broadly triangular-dentate, about 0.2-0.5 mm long; lateral lobes usually acute and triangular-dentate but occasionally broadly rounded, about 0.3-0.8(1.0) mm long; abaxial lobe narrowly triangular-dentate, acute, (0.5)0.8-1.2 mm long. Vexillum about 5-6 mm long about 3.5-4.2 mm wide, broadly obovate, gradually tapering to a rather indistinct claw of about 1-1.5 mm long, moderately to strongly arched, apically broadly rounded

and entire or indistinctly emarginate to irregularly erose, appearing dark reddish-purple either fresh or dried and with the claw and blade enfolding and enveloping the filaments and style. Filaments 6-8 mm long, united into a sheath for the lower 1-2(3) mm, glabrous; anthers 0.4-0.6 mm long, yellow. Style moderately ascending pilose, 5-7 mm long; ovary glabrous or rarely pubescent. Fruit 5-9 mm long and (2.0)3-4.5 mm wide, basally tapering, straight to strongly curved along the abaxial suture and the abaxial suture strongly outwardly bowed, glabrous to densely appressed short-pubescent, conspicuously pustulate-glandular or eglandular. Seeds smooth, reddish-brown, 3.5-4.5 mm long.

Distribution: Southern Quebec south into Florida and west into northern Mexico, southern California, and Wyoming. (Map 15.)

This wide-ranging species is, as one might infer from its lengthy synonymy, extremely variable. Numerous species and/or varieties have been segregated from it in the past and many have been recognized in most recent floristic treatments. The striking variability is such that it might seem reassuring indeed to have a formally designated system by which one could categorize the very dissimilar appearing plants. Unfortunately, however, the examination of many hundreds of specimens soon demonstrates the inadequacy of even the numerous described segregates to convey the extent of the variability encountered not to mention the not inconsiderable number of specimens which clearly match the characteristics of one described taxon in its older growth and another in its younger and more recently formed portions. Clearly then what might be conveniently referred to as the *fruticosa*-complex is an extremely diverse assemblage of populations whose variability is due both to environmentally induced plasticity and also to the presence of a great number of biotypes. I have found it taxonomically unclarifying to attempt to categorize this variability formally by the recognition of the previously



MAP 15. *Amorpha fruticosa.*

segregated species, varieties and forms and have concluded that the variability could best be treated as representing one extremely polymorphic taxon. The alternate approach is exemplified by Steyermark's treatment in the flora of Missouri where as many as four of the five varieties recognized as occurring in Missouri are known from a single county. No indication of ecological preference is suggested to account for at least partial isolation of these populations and they are in fact stated to be "intergrading."

TAXA EXCLUDED FROM THE GENUS AND BINOMIALS AND TRINOMIALS OF UNCERTAIN POSITION

Certain binomials or trinomials have in the interests of completeness been included in the following list which perhaps could have been excluded since they were not validly published. Names published without a diagnosis or description or without a reference to one that was effectively published are *nomina nuda* and hence technically could be ignored (ICBN Art. 32(3)). Also binomials or trinomials which were originally published in synonymy are not validly published (ICBN Art. 34(4)) and hence could be ignored (Art. 12).

Amorpha arborea Hort. ex Schkuhr, Bot. Handb. Deutschl. Gew. 2: 333. 1796. [Publication not seen by me; this binomial was reportedly published as a synonym.]

Amorpha canescens [f.] *glabrescens* Zabel in Beissner *et al.*, Handb. Laubh. Ben. 268. 1903. [Publication not seen by me; reportedly this bionomial was published as a *nom. nud.* and a synonym of *A. canescens* f. *glabrata* (A. Gray) N. C. Fassett.]

Amorpha colorata Raf., Aut. Bot. 81. 1840. [Appalachian Mts.] Rafinesque himself questioningly suggested that it might be *A. caroliniana* Croom, and Merrill (Index Rafinesquianus, p. 142. 1949) suggested, again with a question mark, its identity with *A. nitens* Boynton. I am unable to identify it with any certainty.

Amorpha crocea Hort. ex Lavallée, Arb. Segrez. 60. 1877. [Publication not seen by me but this binomial reportedly appeared as a *nom. nud.*]

Amorpha dealbata Hort. ex Lavallée, Arb. Segrez. 60. 1877. [Publication not seen by me but this binomial reportedly appeared as a *nom. nud.*]

Amorpha discolor Raf., Aut. Bot. 79. 1840. [Alabama.] Merrill (Index Rafinesquianus, p. 142. 1949.) synonymized this binomial with *A. fruticosa* L.

Amorpha elata Hayne, Dendr. Fl. 134. 1822. [Publication not seen by me. Rydberg cited this binomial in the synonymy of *A. fruticosa* L.]

Amorpha elatior Hort. ex Lavallée, Arb. Segrez. 60. 1877. [Publication not seen by me but this binomial is reportedly a *nom. nud.*]

Amorpha flexuosa Raf., Aut. Bot. 80. 1840. [Unaka Mts. of Carolina.] Perhaps a synonym of *A. fruticosa* L. as suggested by Merrill (Index Rafinesquianus, p. 142. 1949).

Amorpha fruticosa var. *fragans* Bean, Trees and Shrubs Brit. Isl. 1: 193. 1914. [Publication not seen by me; Palmer states that the brief description would apparently exclude it from synonymy of *A. fragrans* Sweet but that its identity is undeterminable.]

Amorpha gaertnerii Hort. ex K. Koch, Dendr. 1: 70. 1869. [Publication not seen by me; reportedly a *nom. nud.*]

Amorpha gardnerii Hort. ex. Kirchner, Arb. Musc. 370. 1864. [Publication not seen by me; reportedly a *nom. nud.*]

Amorpha glandulosa Blanco, Flora de Filipinas. ed. 1. 555. 1837. [Philippines.] = *Dalaea glandulosa* (Blanco) Merr., Dept. of Interior, Manila. 37. 1905. = *Thornbera dalea* (L.) Rydb., Fl. N. Am. 24(2): 120. 1920. = *Dalea annua* (Mill.) Kuntze, Rev. Gen. 178. 1891.

Amorpha glauca Raf., Aut. Bot. 80. 1840. [Missouri.] A synonym of *A. fruticosa* L. *s.lat.* as suggested by Merrill (Index Rafinesquianus, p. 142. 1949.)

Amorpha Lewisii Loddiges ex Loudon, Arb. Brit. **2**: 607. 1838. [Publication not seen by me; reportedly published in synonymy.]

Amorpha ludoviciana Hort. ex Lavallée, Arb. Segrez. 60. 1877. [Publication not seen by me but this binomial is reportedly a *nom. nud.*]

Amorpha Ludwigii Hort. ex K. Koch, Dendr. **1**: 70. 1869. [Publication not seen by me; reportedly published in synonymy.]

Amorpha ? lutea Raf., Fl. Ludov. 105. 1817. [Louisiana.] Clearly not an *Amorpha* but its identity has not yet been established.

Amorpha macrophylla Raf., Aut. Bot. 79. 1840. [Florida.] Probably another synonym of *A. fruticosa* L. *s.lat.* as suggested by Merrill (Index Rafinesquianus, p. 142. 1949.). The identity of this name is totally impossible to surmise if one were following Palmer's treatment with its numerous accepted segregates from the *Amorpha fruticosa* complex.

Amorpha marginata Hort. ex Lavallée, Arb. Segrez. 60. 1877. [Publication not seen by me but reportedly the binomial appeared as a *nom. nud.*]

Amorpha non-perforata Schkuhr, Bot. Handb. Deutschl. Gew. **2**: 333. 1796. [Publication not seen. Usually listed in the synonymy of *A. fruticosa* L.]

Amorpha ornata Wenderoth, Ind. Sem. Hort. Marburg. 1835. [Publication not seen by me; reportedly a *nom. nud.*]

Amorpha ovalis M. E. Jones, Contr. West. Bot. no. **16**: 32. 1930. Typification: **Arizona:** Miller Canyon, Huachuca Mts., *M. E. Jones* 25027 (holotype, not seen; isotypes, CAS!, MO!, OKLA!, RM!, UC!) = *Indigofera sphaerocarpa* A. Gray.

Amorpha pedalis Blanco, Flora de Filipinas, ed. 1. 553. 1837. [Philippines.] According to Merrill (Dept. of Interior, Manila. 19. 1905) this is probably *Solominia oblongifolia* DC. (Polygalaceae).

Amorpha perforata Schkuhr, Bot. Handb. Deutschl. Gew. **2**: 333. 1796. [Publication not seen. Usually listed in the synonymy of *A. fruticosa* L.]

Amorpha rabiae Lexarza, Nov. Veg. Desc. fasc. I. 22. 1824. [Michoacan, Mexico.] Palmer (Jour. Arn. Arb. **12**: 197. 1931) presents a resumé of the original description. It does not possess the characters of an *Amorpha* but its identity is otherwise uncertain.

Amorpha retusa Raf., Aut. Bot. 80. 1840. [Appalachian Mts.] Probably a snyonym of *A. fruticosa* L.; Rafinesque's description mentioning its tomentose leaflets and acute calyx-lobes would certainly exclude the possibility of its being *A. glabra* as was suggested by Merrill (Index Rafinesquianus, p. 142. 1949) and Rehder (Bibliogr. Cult. Trees and Shrubs. 369. 1949).

Amorpha tomentosa ? Raf., Fl. Ludov. 105. 1817. [Louisiana.] Identity uncertain as all that Rafinesque states about it is "a doubtful species, of which Robin only mentions it being tomentose . . ." Rydberg (N. Am. Fl. **24** (1) : 27. 1919) questioningly placed it in the synonymy of *A. paniculata* but the description is far too incomplete to allow anyone to identify the plant being described. It is not even certain that it is an *Amorpha*.

Amorpha tomentosa Raf., Aut. Bot. 81. 1840. not Raf., Fl. Ludov. 105. 1817. ["On Wabash and West Kentucky."] Merrill (Index Rafinesquianus, p. 142. 1949) questioningly suggests that it might be a synonym of *A. canescens* Pursh but that species is unknown to me from "West Kentucky" one of the two cited localities.

Amorpha verrucosa Raf. Aut. Bot. 80. 1840. [Alabama.] Merrill (Index Rafinesquianus, p. 142. 1949) suggested this binomial was a synonym of *A. fruticosa* L. and I would agree that the original description is vague enough to fit the very broad concept I have of the species, although it would be impossible to tell to which of the segregates recognized by Palmer from the *A. fruticosa* complex that Rafinesque's species belongs.

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PAPAVER IN NORTH AMERICA NORTH OF MEXICO[1]

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The following diagnostic treatment includes the native and introduced species of *Papaver* found in North America north of Mexico. It is primarily synthetic in nature and is based in large part on the works cited under "Literature," as well as on the collection of specimens in the United States National Herbarium, Smithsonian Institution. This treatment is not offered as a definitive revision, the achievement of which will require extensive study in the field, herbarium and laboratory. In some cases, existing collections are very inadequate, and this is especially true of the problematic scapose poppies. In view of the present confused situation with regard to the latter in North America, a broad species concept is here adopted for them. In this arctic and alpine complex many species of dubious merit have been proposed, some on the basis of only one or a few specimens and with little regard for the overall generic context. Much importance has been accorded chromosome numbers in some instances, but until the complex cytological patterns in *Papaver* are fully investigated and their relationships to morphological patterns analyzed, such data contribute little to sound taxonomic circumscriptions and dispositions.

When the native North American species of *Papaver* are better known, it is probable that some taxa herein submerged in broadly conceived species will be recognized separately at the specific and varietal levels. Until such time, however, practicality and fidelity to what is actually

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[1]Based on a study conducted for the Flora North America Program, supported by National Science Foundation Contract C-757 with the Smithsonian Institution.

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known about the native poppies seem best served by a synoptic approach utilizing these broad taxa. I have made no attempt to relate the introduced poppies to the many infraspecific taxa that have been proposed for those species in their native ranges. This would be virtually impossible on the basis of the morphologies of most individual plants found in North America. Any such correlations which could be made would be essentially meaningless in the North American context, within which, due to geographically random introductions and subsequent hybridizations, there is no biologically significant pattern of variation in evidence.

The sectional nomenclature utilized herein follows that presented in my recent review of the subject (Kiger, 1973). The circumscriptions and descriptions of sections generally follow the traditional ones of existing revisions, particularly that by Fedde (1909). Only characters of species found in North America north of Mexico are included in the sectional descriptions. The descriptions of all taxa follow the outline and glossary developed for Flora North America (Porter, *et al.*, 1973).

Papaver L., Sp. Pl., 506. 1753; Gen. Pl. ed. 5, 224. 1754.

Plants annual or perennial, herbaceous, caulescent, subscapose or scapose, monoclinous, sap gummy, opaque. Main stems eramous or ramose. Leaves alternate, sometimes basally rosulate; blades entire to bipinnatipartite. Flowers solitary, pedicellate or scapose, actinomorphic, complete, syncarpous, apostemonous. Sepals 2, free, caducous, entire. Petals 4, entire, aestivation corrugate. Stamens numerous. Carpels 3-18; styles absent; stigmas 3-18, sessile, radiate on a disc, interstigmatic membrane usually present, often conspicuous. Fruits capsular, dehiscence poricidal, pores subapical, 3-18, locules 3-18.

KEY TO SPECIES

a. Plants caulescent or rarely subscapose, at least a few cauline leaves present. b.
b. Upper cauline leaves amplexicaulous. .... 1. *P. somniferum.*
b. Upper cauline leaves not amplexicaulous. c.
c. Ovaries and capsules setose. .. 5. *P. hybridum.*
c. Ovaries and capsules glabrous. d.
d. Plants perennial; stems eramous; petals 5 cm or more long. ..... 6. *P. orientale.*
d. Plants annual; stems ramose; petals less than 5 cm long. e.
e. Stigmatic disc depressed-conic, usually umbonate. ..... 4. *P. californicum.*
e. Stigmatic disc essentially plane. f.
f. Pedicels markedly patent hispid distally; capsules less than twice as long as broad. ..... 2. *P. rhoeas.*
f. Pedicels strongly appressed hispid distally; capsules twice as long as broad. ..... 3. *P. dubium.*

a. Plants scapose, leaves all basal. g.
g. Leaves entire to 3 (rarely 5)-lobed, essentially glabrous; capsules obovoid-obconic. ... 9. *P. walpolei.*
g. Leaves pinnatipartite or bipinnatipartite with more than 5 lobes, variously vestite, at least when young; capsules narrowly clavate to globose. h.
h. Setae on ovaries and capsules basally tuberculate. i.
i. Petals salmon pink to yellow, paler basally; Rocky Mountains. ..... 7. *P. alpinum.*
i. Petals white to rose with yellow basal spot; Alaska. ..... 8. *P. alboroseum.*
h. Setae on ovaries and capsules not basally tuberculate. j.
j. Stigmatic disc distinctly conic and/or umbonate. k.

k. Leaves mostly bipinnatipartite; capsule obovoid. ..... 11. *P. mcconnellii.*

k. Leaves mostly pinnatipartite; capsule narrowly oblong-cylindric to clavate. ..... 10. *P. macounii.*

j. Stigmatic disc essentially plane. l.

l. Mature plants over 25 cm tall; petals 4-6 cm long; scapes glabrate to sparsely vestite. ..... 13. *P. nudicaule.*

l. Mature plants less than 25 cm tall; petals to 4 (rarely to 5) cm long; scapes moderately to densely vestite. ..... 12. *P. lapponicum* ssp. *occidentale.*

SECT. PAPAVER

Plants annual, caulescent, glaucous, glabrate. Leaf blades simple or pinnatipartite. Basal leaves petiolate. Cauline leaves sessile, upper amplexicaulous. Filaments clavate. Stigmatic disc essentially plane. Fruits globose or subglobose, glaucous, glabrous.

1. **P. somniferum** L., Sp. Pl., 508. 1753.

Plants 3-15 dm tall. Main stems distally cauliramous, stout; branches few. Leaf blades simple and coarsely bidentate, or pinnatipartite with lobes irregularly dentate. Pedicels glabrate or sparsely pale setose distally. Petals white, pink, red or purple, darker spotted basally, 3.5-6.0 cm long. Filaments white; anthers pale yellow. Stigmas 5-18, disc margin deeply lobed, membrane conspicuous. Fruits usually stipitate, 3-9 cm long, not ribbed.

Adventive locally throughout the United States and Canada as far north as Newfoundland, introduced from Europe, native of Eurasia; fields, roadsides and waste places, especially about habitations; flowering June-September.

SECT. RHOEADES Bernh.

Plants annual, caulescent or subscapose, glabrous, pilose, hirsute, hispid or setose. Leaf blades pinnatipartite or bipinnatipartite. Basal leaves petiolate. Cauline leaves sessile, not amplexicaulous. Filaments filiform. Stigmatic disc essentially plane, sometimes umbonate, margin lobed, lobes rounded to obtuse. Fruits glabrous.

2. **P. rhoeas** L., Sp. Pl., 507. 1753.

Plants caulescent, hispid or setulose, 2.5-9.0 dm tall. Main stems distally cauliramous, slender to stout. Leaf blades pinnatipartite or bipinnatipartite, lobes acuminate, coarsely dentate. Cauline leaves often somewhat clustered beneath the pedicels. Pedicels sparsely to moderately patent hispid or setulose. Petals pink to red, sometimes darker spotted basally, 2.0-4.5 cm long. Filaments purple; anthers bluish. Stigmas 5-18, disc essentially plane, broader than capsule apex, membrane conspicuous. Fruits slightly stipitate or sessile, broadly obovoid or subglobose, 1-2 cm long, obscurely ribbed, glaucous.

Adventive locally throughout the United States and Canada as far north as Alaska, introduced from Europe; fields, roadsides and disturbed sites, especially about habitations; flowering March-October.

3. **P. dubium** L., Sp. Pl., 1196. 1753.

Plants caulescent or subscapose, 2-6 dm tall. Main stems basicauliramous, hirsute to hispid. Basal leaf blades pinnatipartite, glaucescent, hispid. Cauline leaf blades bipinnatipartite, glaucescent, hispid. Pedicels distally appressed hispid, proximally patent hispid. Petals red, sometimes darker spotted basally. Filaments purple; anthers violet. Stigmas 7-9, disc essentially plane. Fruits sessile or slightly stipitate, obovoid, L:W::2:1, usually distinctly ribbed, glaucous.

Naturalized locally throughout the contiguous United States, introduced from Europe; fields, roadsides, thickets, disturbed sites, especially near habitations; flowering May-August.

4. **P. californicum** A. Gray, Proc. Amer. Acad. 22: 313. 1887.

P. lemmonii Greene

Plants caulescent, glabrous or sparsely pilose, 3-6 dm tall. Main stems distally cauliramous, slender. Leaf blades pinnatipartite or bipinnatipartite, lobes sometimes dentate. Petals red, greenish spotted basally, 1-2 cm long. Filaments greenish yellow; anthers yellow. Stigmas 5-8, disc plane to depressed-conic, usually umbonate, not broader than capsule apex, membrane conspicuous. Fruits sessile, ellipsoid to obovoid-turbinate, 1-2 cm long.

Native, endemic to western California; chaparral and oak woodlands in the mountains at elevations below 800 m, especially in clearings, burns and other disturbed sites; flowering April-May.

Sect. Argemonidium Spach

Plants annual, caulescent, pilose, villous or hispid. Leaf blades pinnatipartite or bipinnatipartite. Basal leaves petiolate. Cauline leaves sessile, not amplexicaulous. Filaments clavate. Stigmatic disc convex and vaulted, lobes obtuse. Fruits setose.

5. **P. hybridum** L., Sp. Pl., 506. 1753.

P. apulum Ten. var. *micranthum* (Boreau) Fedde misappl.

Plants 1-5 dm tall. Main stems basiramous and cauliramous. Pedicels moderately to densely appressed to spreading hispid. Petals red, darker spotted basally. Filaments dark violet; anthers pale blue. Stigmas 4-8, disc deciduous at maturity. Fruits sessile, obovoid to subglobose,

1.0-1.5 cm long, obscurely to distinctly ribbed, vestiture recurved-arcuate, spreading or ascending.

Naturalized locally in California, introduced from Eurasia; fields, vineyards and disturbed sites; flowering March-May.

Specimens attributed to *P. apulum* var. *micranthum* in herbaria and reported as such in Munz and Keck (1959) and in Munz (1968) belong here.

SECT. OXYTONA Bernh.

Plants perennial, robust, caulescent, hispid. Leaf blades pinnatipartite. Basal leaves petiolate. Cauline leaves sessile, not amplexicaulous. Flowers very large. Filaments clavate. Stigmatic disc plane. Fruits subglobose, glaucous, glabrous.

6. **P. orientale** L., Sp. Pl., 508. 1753.

Plants 6-10 dm tall. Main stems eramous. Leaf lobes aristate. Pedicels moderately to densely appressed pale hispid. Petals pale orange, sometimes pale spotted basally, 5-8 cm long. Filaments purple; anthers violet. Stigmas 13-18. Fruits sessile, to 3.5 cm long.

Adventive locally in the middle-Atlantic United States, escaping from cultivation, introduced from Europe, native of southwest Asia; fields and disturbed sites; flowering in May.

Papaver bracteatum Lindl., which some consider distinct from *P. orientale,* has deep red petals and has foliaceous bracts subtending the sepals. It is occasionally cultivated and might be found as an escape.

SECT. LASIOTRACHYPHYLLA Bernh.

Plants perennial, scapose. Main stems eramous. Basal leaves petiolate, rosulate, blades simple, pinnatipartite or bipinnatipartite. Cauline leaves absent. Stigmatic disc plane to conic, sometimes vaulted, sometimes umbonate. Fruits setose.

7. **P. alpinum** L., Sp. Pl., 507. 1753.

P. pygmaeum Rydb.

P. nudicaule L. ssp. *radicatum* (Rottb.) Fedde var. *pseudocorydalifolium* Fedde

Plants cespitose. Leaf blades pinnatipartite or bipinnatipartite, glabrate or sparsely hispid. Scapes erect, to 10 cm tall, sparsely hirsute. Petals yellow to salmon pink, paler spotted basally, to 1 cm long. Stigmas usually 5, disc vaulted. Fruits obovoid-cylindric or ellipsoid, whitish setose, trichomes basally tuberculate.

Native to Montana, Alberta and British Columbia; talus slopes in the Rocky Mountains from 1500 to 2700 m; flowering July-August.

For discussion of the relationship of these plants to European and Asian members of the complex see D. Löve (1969).

8. **P. alboroseum** Hult., Fl. Kamtchatka 2, Sv. Vet.-Akad. Handl. ser. 3, 5, no. 2: 141, *t. 3*, f. c. 1928.

Plants cespitose, caudex short. Leaf blades bipinnatipartite, pale setose above and beneath, primary lobes 2-5-partite. Scapes arcuate-ascending, to 15 cm tall, setose. Petals white to rose, yellow spotted basally. Stigmas 5-6, disc essentially plane. Fruits ovoid to globose, ribbed, whitish to brown setose, trichomes basally tuberculate.

Native to the Kenai Peninsula, Alaska, also to Kamtchatka, U. S. S. R.; sandy and gravelly soils at low elevations.

9. **P. walpolei** Pors., Rhodora **41**: 231. 1939.

Plants densely cespitose. Leaf blades entire or pinnatipartite, subcoriaceous, glabrous, lobes (when present) 3, rarely 5, broadly obtuse, margins revolute, petiole bases conspicuously persistent. Scapes erect, to 16 cm tall, hirsute or hirtellous distally. Petals pale yellow or cream and

yellow spotted basally, to 2.5 cm long. Stigmas usually 5, disc conic, broader than capsule. Fruits obovoid-obconic, 1.5 cm long, pale yellowish setose or setulose, trichomes slender, basally tuberculate, sometimes only obscurely so.

Native to the Seward Peninsula, Alaska, also to northeastern Asia; tundra from sea level to ca. 800 m on mountain slopes in gravelly loam and solifluction soils, often of limestone origin; flowering May-August.

10. **P. macounii** Greene, Pittonia 3: 247. 1897.

P. keelei Pors.
P. alaskanum Hult. var. *macranthum* Hult.
P. scammianum D. Löve
P. hultenii Knaben
P. microcarpum DC., misappl.
P. nudicaule L., misappl.

Plants solitary to densely cespitose. Leaf blades pinnatipartite or rarely bipinnatipartite, glabrate to pilose. Scapes erect, to 4 dm tall, moderately pilose. Petals yellow. Stigmas 3-5, disc conic, umbonate, sometimes vaulted. Fruits narrowly oblong or clavate, L:W::2:1, setose, trichomes not basally tuberculate.

Native and widespread in Alaska, Yukon Terr., Northwest Terr. and British Columbia; sandy and gravelly soils, heaths, thickets, meadows, often on slopes, to over 2100 m.

11. **P. mcconnellii** Hult., Fl. Alaska & Yukon 5, Lunds Univ. Arssk. N. F. Avd. 2, 41, no. 1: 803, *f. 1*. 1945.

Plants cespitose, to 15 cm tall. Leaf blades bipinnatipartite, rarely pinnatipartite, glaucous, sparsely pilose above and beneath. Scapes erect, pilose. Petals yellow. Stamens usually shorter than mature ovary. Stigmatic disc convex, distinctly apiculate-umbonate, membrane conspicuous. Fruits obovoid, pale setose, trichomes not basally tuberculate.

Endemic to Yukon Terr.; sandy and gravelly soils.

12. **P. lapponicum** (Tolm.) Nordh. ssp. *occidentale* (Lundstr.) Knaben, Op. Bot. 2, 3: 55. 1959.

P. radicatum Rottb. ssp. *lapponicum* Tolm.
P. radicatum ssp. *occidentale* Lundstr.
P. lapponicum ssp. *porsildii* Knaben
P. nudicaule L. ssp. *radicatum* (Rottb.) Fedde var. *coloradense* Fedde
P. nudicaule ssp. *radicatum* var. *columbianum* Fedde
P. kluanensis D. Löve
P. freedmanianum D. Löve
P. nigroflavum D. Löve
P. cornwallisensis D. Löve
P. alaskanum Hult. var. *alaskanum*
P. denalii Gjaerevoll
P. radicatum Rottb. ssp. *radicatum*, misappl.

Plants cespitose. Caudex short to elongate. Leaf blades mostly bipinnatipartite, pilose; petiole bases usually persistent, sometimes conspicuously so, pale to dark brown. Scapes ascending to erect, to 20 (rarely 25) cm tall, sparsely to moderately appressed to patent hispid or pilose. Petals yellow or rarely white. Stigmas 5-8, disc plane to slightly convex, sometimes vaulted. Fruits subglobose, ellipsoid or obovoid, setose, trichomes not basally tuberculate.

Native and widespread in arctic North America from Greenland to Alaska, extending southward in disjunct populations in the Rocky Mountains to Colorado and northern New Mexico at high elevations, also in Lapland; sandy and gravelly soils, often on talus, arctic and alpine tundra to ca. 3000 m.

For discussions of the proper typification of *P. radicatum* Rottb. and its bearing on the nomenclature in this complex see A. Löve (1962a, 1962b), Knaben (1958) and Knaben and Hylander (1970). The latter interpretation is here accepted. See D. Löve (1969) for discussion of the Rocky Mountain plants of this complex, held separate by her.

13. **P. nudicaule** L., Sp. Pl., 507. 1753.

Plants cespitose. Leaf blades pinnatipartite, less frequently bipinnatipartite, glabrate or setose. Scapes erect, 25-50 cm tall, stout, glabrate or sparsely hispid. Petals yellow, red or white. Stigmas 4-6, disc plane, membrane obsolescent. Fruits clavate or obovoid, setose, trichomes not basally tuberculate.

Adventive locally in Alaska and Yukon Terr., escaping from cultivation, native to arctic and alpine Asia; roadsides and disturbed sites, especially about habitations.

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THE NORTH AMERICAN SPECIES, BOERHAVIA SPICATA (NYCTAGINACEAE), IN NORTHWESTERN ARGENTINA

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Boerhavia spicata Choisy is a morphologically variable herb widespread in the Sonoran and Chihuahuan deserts of the southwestern United States and northern Mexico, and heretofore known only from that region. During the course of field study as a worker in the IBP Structure of Ecosystems Program, I found an isolated population of this species in Catamarca Province, Argentina. This constitutes the first known occurrence of the species in South America, and is an addition to the already sizable list of species known to have range disjunctions between the desert regions of southwestern North America and northern Argentina and Chile (Bray, 1900; Johnston, 1940; Raven, 1963; Solbrig, 1972).

Plants of *Boerhavia spicata* occur abundantly on a small group of sand dunes located 35 km west of the town of Andalgalá, at the north edge of the Bolsón de Pipanaco. In spite of extensive field work in the Andalgalá region over an eight-month period in 1972-73, no other populations, or even isolated individuals, of the plant were found. Several Argentine botanists familiar with the flora of the region were consulted, and none had seen the species previously. In addition, a literature search revealed no references to the occurrence of *B. spicata* or other species with similar characteristics in South America.

I considered the possibility that the population might represent an undescribed species. An inspection of the worldwide collection of *Boerhavia* at the Harvard University Herbaria revealed a strong resemblance between the Argentine specimens and members of the *B. spicata* complex (explained below). No marked resemblance was found to any other species of *Boerhavia*.

The *Boerhavia spicata* complex has been considered by a number of authors (Standley, 1909; Tidestrom and Kittell, 1941; Kearney and Peebles, 1960; Ferris, 1964) to consist of three to four distinct species: *B. spicata* Choisy, *B. watsonii* Standley, *B. coulteri* (Hook. f.) S. Watson, and *B. torreyana* (S. Watson) Standley. More recently it has been interpreted as a single morphologically variable species, *B. spicata* Choisy (Reed, 1969). Upon examination of the Harvard Herbaria collection of the complex (50 specimens), I tend to agree with Reed's interpretation that we are dealing with a single variable species. The characters used by the above-mentioned authors to distinguish the four species (e.g., degree of crowding of the flowers in the inflorescence; shape of the ridges and furrows of the anthocarp; degree of rugosity of the anthocarp; presence or absence of glandular pubescence on the stems and glandular dots on the foliage) all show gradual variation between the extreme character states. However, the species should, perhaps, be segregated into two varieties —one, with a center of distribution in the Sonoran Desert, having a tendency towards closely spaced flowers, acute to acuminate leaf-apices, and densely glandular-villous stems; and the other, with a center of distribution in the Chihuahuan Desert, having a tendency towards loosely spaced flowers, obtuse leaf apices, and puberulent stems with few or no glands. The Argentine population clearly has affinities with the latter variety.

The above analysis is intended as a suggestion only. I do not feel justified in dividing the species into varieties based solely on the very limited herbarium study that I have done. Crossing experiments in the laboratory and a field study of ecotypic variation would help greatly to clarify the taxonomic relationships within this difficult complex. Meanwhile, for the purposes of identifying the Argentine population, I am following Reed in his placement of the entire complex in the species *Boerhavia spicata* Choisy. The Argentine plants are clearly members of the complex; thus until someone does a definitive revision of the genus, they should be placed in *B. spicata* Choisy.

The following description is patterned after Reed's description of *Boerhavia spicata* but has been modified so as to describe the Argentine population rather than the species as a whole:

Erect or decumbent annual from a slender taproot, usually with many branches spreading from the base; stems 2-6 dm long, much branched, often tinged with pink, white-puberulent on the lower parts (occasionally sparsely glandular-hirtellous at the nodes only), glabrous on the upper parts; leaves opposite, the petioles puberulent, 0.2-3.0 cm long, the leaf-blades oval to ovate or ovate-lanceolate, 0.8-4.0 cm long, 0.4-2.5 cm wide, truncate to obtuse or slightly oblique at base, obtuse to acuminate at the apex, the margins entire to sinuate, green above, paler beneath, brown-punctate or not, sparsely puberulent to glabrate; inflorescence cymose-paniculate, spreadingly much-branched, the branches slender, glabrous; flowers on short pedicels 0.3 to 1.0 mm long, loosely spaced on the ultimate branches of the inflorescence; bracts minute, deciduous, ovate to lanceolate, pinkish, ciliolate; perianth pale pink, 1.5 mm long, puberulent; stamens 2, short-exserted; anthocarp narrowly obovoid, 3 mm long, 1 mm wide, rounded at apex, acute at the base, 5-angulate, the sulci nearly closed, strongly rugose.

Specimens (*Cantino* 664, 724) are deposited in the herbaria of the following institutions in the United States and Argentina: Harvard University, University of Michigan, University of Arizona, New Mexico State University, University of Texas, Instituto Miguel Lillo (Tucumán), Universidad Nacional de Córdoba, and Instituto de Botánica Darwinion (San Isidro).

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GEOGRAPHICAL DISTRIBUTION OF THE CEDAR GLADE ENDEMIC VIOLA EGGLESTONII

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Viola egglestonii Brainerd is a perennial, stemless, blue violet that heretofore was thought to be endemic to the cedar glades of central Tennessee. Distribution maps published by Russell (1958, 1965) show the species as occurring in four counties, and Baskin and Baskin (1970) list five additional counties making a total of nine in the Central Basin of Tennessee. These counties include Bedford, Cannon, Davidson, Marshall, Maury, Rutherford, Smith, Sumner and Wilson. *Viola egglestonii* previously has been reported from Warren (Brainerd, 1921) and Hart (Braun, 1943) counties in south-central Kentucky, but Russell (1965) in his extensive treatment of the violets of central and eastern United States could not find specimens to verify its occurrence in Kentucky. The purpose of this note is to report the discovery of populations of *V. egglestonii* in cedar (limestone) glades in Kentucky, Georgia and Alabama.

On 15 April 1972 we discovered a population of *Viola egglestonii* in a cedar glade area in Bullitt Co., Kentucky, along Co. Rd. 1604, 0.3 miles south of St. Rd. 480 (*Baskin & Baskin* 1191). Two additional populations were found on 23 April 1972 in cedar glades in Bullitt Co. The locations of these two populations are: Woodsdale Rd., 1.3 miles east of Deatsville Rd. (*Baskin & Baskin* 1225); Bells Mill Rd., 2.6 miles east of U.S. 61 (*Baskin & Baskin* 1234). An additional population was found in Bullitt Co. on 1 April 1973 on Clarks Lane, 0.7 miles north of St. Rd. 480 (*Baskin & Baskin* 1639).

Populations of *Viola egglestonii* were found in cedar glade areas in Walker and Catoosa counties, Georgia, on 26 May 1972. The locations of these populations are as follows: Walker Co., along U.S. 27, 5.1 miles south of St. Rd. 2 (*Baskin & Baskin* 1301); Walker Co., along U. S. 27,

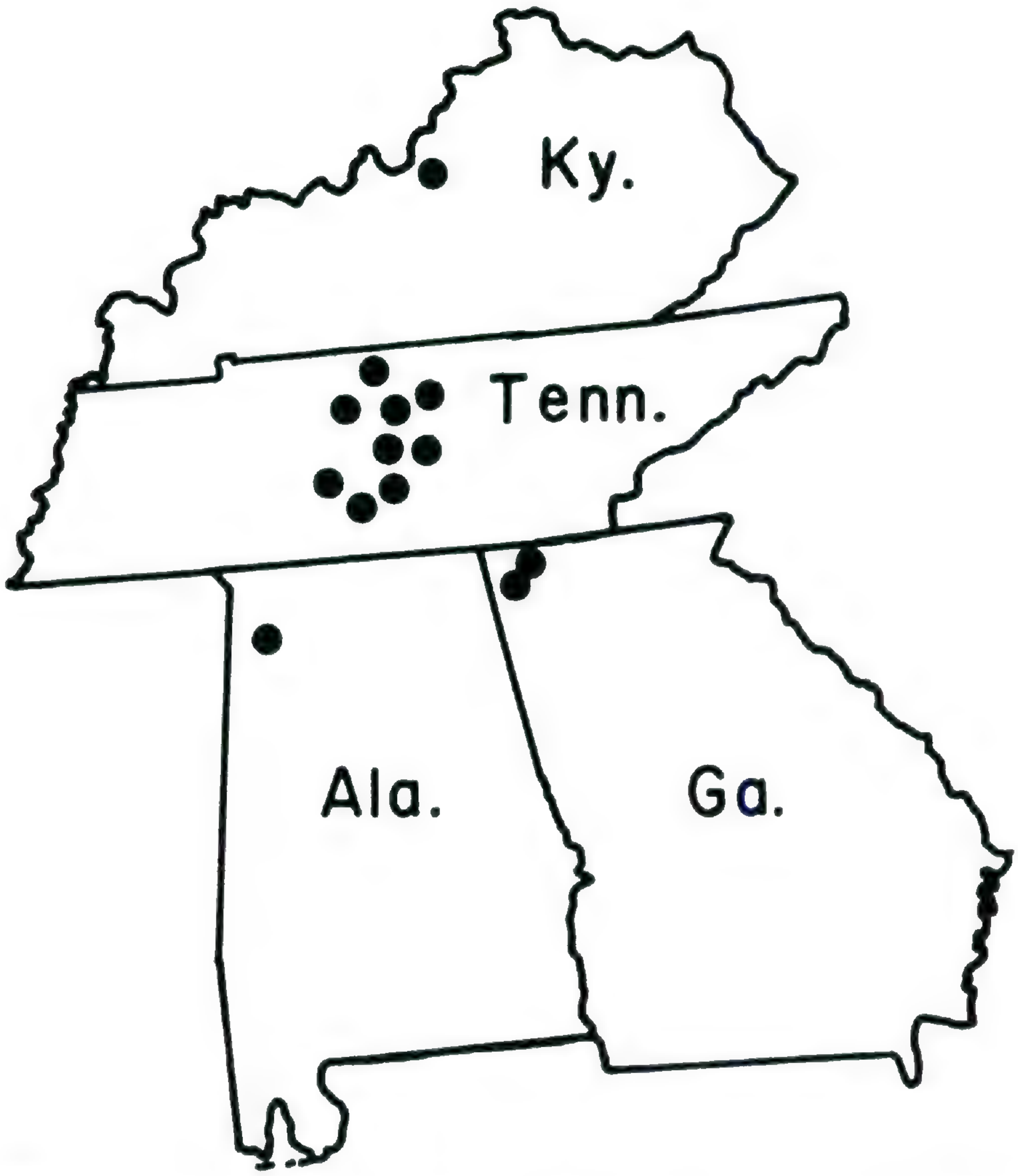

Fig. 1. Geographical distribution of *Viola egglestonii*. Each dot represents a county where the species is known to occur.

4.8 miles south of St. Rd. 2 (*Baskin & Baskin* 1306); Catoosa Co., Chickamauga National Park, 2 miles east of Ft. Oglethorpe on Co. Rd. 2 (*Baskin & Baskin* 1308).

On 27 May 1972 a population of *Viola egglestonii* was found in a cedar glade in Franklin Co., Alabama. This population occurs along Co. Rd. 83, 0.6 miles north of St. Rd. 24 (*Baskin & Baskin* 1328).

The present known geographical distribution of *Viola egglestonii* is shown in Fig. 1. Herbarium specimens from

the new locations reported in this note have been sent to the herbarium at Vanderbilt University (VDB).

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RECENT ADDITIONS TO THE MARINE ALGAL FLORA OF NAHANT, MASSACHUSETTS[1]

E. E. Webber

The only comprehensive volume to date treating the benthic marine algae of northeastern North America is that of Taylor (1957). In addition to the systematics and species descriptions of relevant plants, Taylor also presents a brief historical summary of marine phycology from the late 1800's to approximately the mid-1950's.

Since that time, however, studies of benthic marine algae in New England have progressed rapidly. A summation of recent research dealing with algae of the sublittoral, with those of estuaries and adjacent salt marshes, and with the autecology of several species, has been published (Webber, 1975). This paper also contains a preliminary tabulation of 107 benthic algae specifically from the vicinity of the Marine Science Institute at Nahant.

In the early summer of 1973 nineteen additional species were collected, mostly from the Nahant rocky shore, and a few from a nearby salt marsh. These are listed below.

References used in determinations of the species were: Farlow (1882), Koster (1955), Taylor (1957), Bliding (1963), Cardinal (1964), Wilce (1965), and Drouet (1968). Extended comments on these species will be reserved for forthcoming publications.

LIST OF SPECIES

Cyanophycophyta

Oscillatoria lutea Ag. — Forming a 2 mm thick mat on deeply shaded and moist rocks just above high tide mark; mixed with *Microcoleus vaginatus* (Vauch.) Gom.

Rivularia atra Roth — epilithic in 2 small rock pools in spray zone.

Tolypothrix sp. and *Cylindrospermum sp.* — collected from salt marsh soil, mid-littoral.

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[1]Contribution No. 14 from the Marine Science Institute, Nahant, Massachusetts 01908.

Chlorophycophyta

Tetraspora sp. — Located at the bases of the marsh grass, *Spartina patens* Ait. (Muhl.) upper littoral.

Pringsheimiella scutata (Reinke) Schmidt et Petrak — collected once, attached to the operculum of *Littorina obtusata*.

Blidingia marginata (J. Ag.) Dangeard ssp. *marginata* — commonly epilithic at and just above high tide level.

B. marginata ssp. *subsalsa* (Kjell.) Bliding — located immediately above *B. marginata*.

Enteromorpha compressa (L.) Grev. var. *compressa* — occurs in quantity in a splash zone pool at the top of the very exposed East Point rocks.

E. ahlneriana Bliding — common in tide pools at high tide level.

E. clathrata (Roth) Grev. (type I) — attached to small stones in the lower littoral zone of Lynn Harbor.

E. clathrata (Roth) Grev. (type II) — entangled with *Cladophora sp.* in the lower littoral zone of Lynn Harbor.

E. flexuosa (Wulfen ex Roth) J. Ag. ssp. *flexuosa* — growing on shells in the lower littoral zone of Lynn Harbor.

Urospora collabens (C. Ag.) Holmes et Batters — commonly epilithic in the mid-littoral zone at Nahant, often mixed with *Codiolum gregarium* A. Braun.

Rhizoclonium riparium (Roth) Harv. f. *riparium* — while *R. tortuosum* is the common species of this genus at Nahant, *R. riparium* was located in one splash-zone tide pool at the East Point rocks.

Phaeophycophyta

Ectocarpus fasciculatus var. *refractus* (Kutz.) Ard. — common on *Laminaria* stipes; previously reported by Taylor (1957) only from Maine, as an epiphyte on *Porphyra*.

Myriotrichia filiformis Harv. — epiphytic on *Chordaria flagelliformis* in a lower littoral zone tide pool.

Saccorhiza dermatodea (De la Pyl.) J. Ag. — epilithic at 8 to 20 foot depths, mixed with *Laminaria saccharina* (Wilce, 1965) and *L. digitata*. Published accounts of *S. dermatodea* along the northeast coast suggest that this species is limited to coastal waters north of Cape Ann, Massachusetts (Farlow, 1882; Lamb and Zimmermann, 1964; Stone, et. al., 1970; Mathieson and Fralick, 1972). However, records for the distribution for *Saccorhiza* in New England (Taylor, personal communication) reveal that plants of this species extend southward to the Cape Cod (Sandwich, Massachusetts) area. Indeed, *S. dermatodea* is known from the sublittoral at both ends of the Cape Cod Canal (Wilce, personal communication).

Rhodophycophyta

Nemalion multifidum (Weber et Mohr) J. Ag. — epilithic in the upper sublittoral, uncommon, only female plants located.

ACKNOWLEDGMENTS

Appreciation is expressed to Dr. W. Randolph Taylor for sending me collection records of *Saccorhiza dermatodea* from his personal herbarium. Plants of this species were collected simultaneously at Nahant (July 14, 1973) by Jane Menge and Barry Spracklin.

In addition, *Myriotrichia filiformis*, *Nemalion multifidum*, and *Rivularia atra* were collected initially by Jane Menge, while *Prigsheimiella scutata* was located by Barry Spracklin.

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LACTUCA MURALIS IN MAINE

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In a letter dated November 15, 1969, Mrs. Roberta G. Poland of South Deerfield, Mass. reported finding *Lactuca muralis* (L.) Gaertn. on Mt. Desert Island in Salisbury Cove, Hancock County, Maine on August 16, 1969. It was collected from a small group of plants that were still in good condition when checked again in 1970 and 1971. Voucher specimens have been deposited in the Jesup Herbarium at Dartmouth College (HNH), in the University of New Hampshire Herbarium (NHA), in the Pringle Herbarium at the University of Vermont (VT), and in the herbarium of the University of Massachusetts at Amherst, Mass. (MASS). Collection of this species in Cornish, Sullivan County, N.H. was reported in Rhodora 68:774, 1966. At that time Professor Albion R. Hodgdon at the University of New Hampshire wrote that the Cornish discovery was the first report of the species in New England, and Frank C. Seymour's *Flora of New England* published in 1969 lists Cornish as the only New England station. Mrs. Poland's discovery represents a really disjunctive jump.

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LACTUCA MURALIS IN BRITISH COLUMBIA

JOHN T. WITHERSPOON AND THOMAS J. WATSON, JR.

Lactuca muralis (L.) Gaertn. was recently collected in British Columbia (KOA campground, ca. 10 mi W of Hope, 2 Sept. 1973, *Watson* 1048). The specimen is deposited at MONTU. This is the most inland known record in British Columbia as well as the farthest north in the foothills of the Cascade Mountains. The locality, latitude 49°20′N longitude 121°40′W, is approximately the same longitude as a reported locality in the Cascade foothills of Marion County, Oregon (Peck, 1961).

Lactuca muralis is an introduction from northern Europe and is sparingly adventive in North America. In eastern North America it is known from western Quebec, eastern New York and west to Michigan (Fernald, 1950; Gleason and Cronquist, 1963). It was recently reported from New Hampshire (Poole, 1966).

It is apparently more common in the eastern parts of North America and previous to this report it was known only from the Oregon locality above, Clallam County and San Juan Island, Washington, and from Lake Cowichan, Vancouver Island, British Columbia in western North America (Hitchcock, *et al.*, 1955). It seems to be migrating slowly inland, both eastward and northward in mainland British Columbia.

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CHIMAPHILA MACULATA IN NEW HAMPSHIRE

JAMES P. POOLE

In December, 1966, F. S. Page, Emeritus Professor of Botany at Dartmouth College, collected two specimens of *Chimaphila maculata* (L.) Pursh on a wooded hill two miles south of George Pond and about ½ mile west of the dirt road that borders the west shore of the pond. The plants bore neither flowers nor fruit, but the leaves were sufficiently characteristic for identification. Since in Gray's Manual, 8th edition, this species is listed as growing in southern New Hampshire only, the collection was accessioned in Jesup Herbarium as voucher specimens for what appeared to be a range extension for the species. The following summer, in August, Professor Page guided Professor Carl Wilson and me to the area where the plants had been collected, but careful search over the whole area by the three of us failed to turn up another specimen. In light of our experience it is interesting to quote from the article covering the distribution of this species in Maine and New Hampshire by Albion R. Hodgdon and Lesley M. Eastman in Rhodora 75:162-165 (1973). "In northern New England *Chimaphila maculata* tends to occur as disjunct colonies of a few individuals or sometimes single plants, in this respect resembling some species of orchids. Even with careful searching it is usually impossible to find any more plants after having found a few shoots at any one station. While the stems are of low stature and stand but a few inches above the forest floor, the leaves are conspicuous and easy to detect." In the same article a number of records extending the range of this species in New Hampshire are listed. One collection is listed for Tuftonboro, Carroll County, on Sentinel Mountain, approximately ten miles farther north than George Pond in Grafton County, but I find no record of an earlier collection in Grafton County. I am listing this station as in Enfield, Grafton County, but it is difficult to locate exactly on the

topographic map, so difficult that it could actually be spotted on either side of the boundary separating Enfield from Grantham in Sullivan County. The only other New Hampshire specimen in Jesup Herbarium was collected on a wooded hill in Kensington, Rockingham County, in July 1896, and bears a printed label reading "Ex Herb. Alvah A. Eaton."

JESEP HERBARIUM
DARTMOUTH COLLEGE
HANOVER, N.H. 03755

BOOK REVIEW: WINTER KEYS TO WOODY PLANTS OF MAINE[1]

When one is faced with the task of teaching a field oriented course in introductory taxonomy in the more northern regions of this continent one must, of necessity, give due consideration to those plants that are available during the winter season — our woody vascular plants. I enthusiastically welcome this excellent field manual for the identification of woody plants in winter condition. The authors of this carefully constructed, excellently illustrated work have succeeded in providing a thorough treatment of the woody plants of Maine, native, naturalized and adventive, with nearly 250 species included. The work goes beyond the "clearly" woody species and provides a means for identifying such marginally woody species as *Arceuthobium pusillum*, *Mitchella repens*, *Potentilla tridentata*, *Aralia hispida*, *A. nudicaulis* and *Decodon verticillatus*. The keys are well constructed, strictly dichotomous, and usually employ a minimum of 2-3 characters per lead. Frequently additional information regarding persistent fruits or vegetative features is provided in the leads to further facilitate the identification process. Habitat data are also incorporated in keys where helpful. The value of the manual is greatly enhanced by the superb set of plates of original line drawings, made from fresh material. In addition to drawings of twigs and of critical leaf scar or bud features, the illustrator has provided drawings of leaves and fruits of certain species in which they are frequently found persistent. It is no understatement when the authors claim it to be fully illustrated.

The manual is organized into a "Key to Genera and Aberrant Species" followed by a "Key to Species" with genera

---

[1]Campbell, Christopher S. and Fay Hyland. 1975. Winter Keys to Woody Plants of Maine. Illustrated by Mary L. F. Campbell. University of Maine Press, Orono, Maine. 52 pp + 63 plates. $3.00. Available from: Secretary, Department of Botany, Deering Hall, University of Maine, Orono, Maine 04473.

arranged alphabetically. Additional notes are included at the end of each set of keys providing information regarding infraspecific taxa. Nomenclature follows Fernald, *Gray's Manual of Botany* edition 8. A clear, concise and complete glossary is also provided. The very thorough index not only includes the scientific name, but also lists every conceivable combination of common names (e.g., *Pyrus americana;* American Mountain Ash; Ash, American Mountain; Mountain Ash, American). The back inside cover provides a map of the counties of Maine and a metric-English scale.

The publication is appropriately dedicated to the memory of Professor Merritt Lyndon Fernald, whose long term interest in the plants of New England and northeastern North America found its stimulus in the plants of his boyhood haunts in the vicinity of Orono, Maine. This fine piece of work should be of interest and value to students, amateur and professional botanists, ecologists, horticulturalists, foresters and naturalists of not only Maine, but of her adjacent states and provinces. At $3.00, this is a welcome bargain.

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Cover illustration

Rhododendron canadense **(L.) Torr.**

from

Curtis' Botanical Magazine t.474

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HYBRIDS IN AMERICAN CYATHEACEAE

DAVID S. CONANT

Several small tree ferns collected in a ravine near Cerro de Punta, Puerto Rico, are proposed as a hybrid between *Alsophila dryopteroides* (Maxon) Tryon and *Nephelea portoricensis* (Kuhn) Tryon, both of which were growing abundantly at the site. This is the first unequivocal report of a hybrid in the family.

In addition, six other hybrids are proposed, one on the basis of substantial evidence, and the others on the basis of inference. Four previous reports suggest that hybridization may occur in the Cyatheaceae, but definitive analyses of the parental and hybrid characters were not presented. Holttum and Sen (1961) and Holttum (1963, 1974) report that *Cyathea alternans* (Wall ex Hook.) Presl of Malaya, Sumatra and Borneo might be a series of hybrids between *Cyathea moluccana* R. Br. and *C. squamulata* (Bl.) Copel. on the basis of its indusium and leaf architecture. Gastony (1973) treats *Nephelea concinna* (Kuhn) Tryon as a species but notes the possibility that it is a hybrid between *N. pubescens* (Kuhn) Tryon and *N. Tussacii* (Desv.) Tryon on the basis of intermediate characters of the lamina architecture and partially contracted fertile pinnules.

DEFINITE HYBRIDS

1. **Alsophila dryopteroides** (Maxon) Tryon × **Nephelea portoricensis** (Kuhn) Tryon

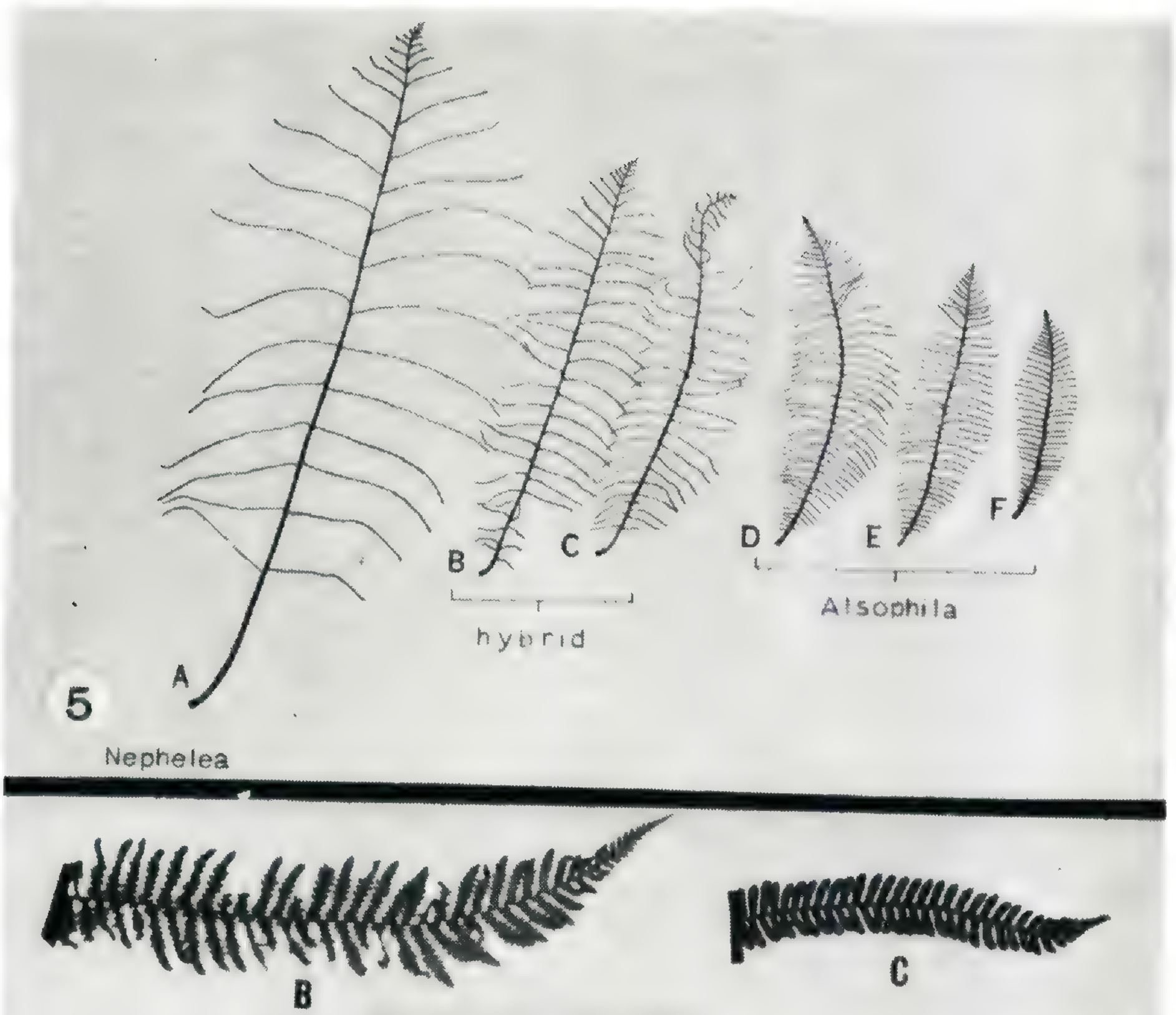
Plants of this hybrid (Fig. 1) resembled large plants of *Alsophila dryopteroides* at a distance, but on closer inspection they were seen to have the black squaminate spines of *Nephelea* on the petiole. Species of Cyatheaceae growing nearby were *Lophosoria quadripinnata* (Gmel.) C. Chr., *Cyathea arborea* (L.) Sm., *C. furfuracea* Baker, *Trichipteris armata* (Sw.) Tryon, *T. borinquena* (Maxon) Tryon, *Alsophila bryophila* Tryon, *A. dryopteroides* (Maxon) Tryon, and *Nephelea portoricensis* (Kuhn) Tryon.

The black squaminate spines on the petiole and rachis (Fig. 10) are a generic character of *Nephelea* (Fig. 12). They firmly establish one parent as *N. portoricensis* since it is the only member of the genus in Puerto Rico. The setate scales on the lamina of the hybrid restrict the second parent to a species of *Alsophila* of which there are three in Puerto Rico; *A. Brooksii* (Maxon) Tryon, *A. bryophila*, and *A. dryopteroides*. *Alsophila Brooksii* is not known from the central mountains where the hybrids grew, it lacks the dark lanceolate type of scale present in the hybrid, and its long petiole is inconsistent with the requirements for the second parental species. Similarly, *A. bryophila* may be eliminated as a possible parent because it also lacks the dark lanceolate type of scale, and a parent with a short rather than a tall trunk is required. *Alsophila dryopteroides* remains as the second possible parent and all of the characters of the hybrid are consistent with this choice.

A detailed comparison of the hybrid and parental species is presented in Table 1. Some of the important characters of the hybrid are in the leaves, stems, and lamina scales.

Characters which are intermediate are lamina shape and dissection, stem, petiole and rachis spininess, number of leaf scars per unit of stem length, and leaf scar diameter. The lance-ovate lamina of the hybrid is intermediate be-

Figs. 1-2. *Alsophila dryopteroides* × *Nephelea portoricensis:* 1, plant, stem ca. 75 cm. tall, leaves ca. 1.0 m. long, *Conant* 679; 2, spore, × 1500, *Conant* 687. Figs. 3-4. *Cnemidaria horrida* × *Cyathea arborea:* 3, plant, stem ca. 2.0 m. tall, leaves ca. 2.5 m. long, *Conant* 626; 4, bicolorous scales on crozier, × 1/3, *Conant* 546. (all specimens GH).



Figs. 5-6. Leaf tracings and pinnae of *Nephelea portoricensis*, *Hybrid*, and *Alsophila dryopteroides:* 5, leaf tracings, A, *N. portoricensis*, B, from *Conant* 679 and C, from *Conant* 680, *Hybrid*, D, from *Conant* 681, E, from *Conant* 690 and F, from *Conant* 682, *A. dryopteroides*, × 1/30; 6, pinnae, A, *Conant* 2002, *N. portoricensis*, B, *Conant* 1980, *Hybrid*, C, *Conant* 1852, *A. dryopteroides*, × 1/5. (all specimens GH).

tween the oblanceolate lamina of *A. dryopteroides* and the ovate lamina of *N. portoricensis* (Fig. 5). The lamina dissection of the hybrid is bipinnate-lobed which is intermediate between the pinnate-pinnatifid condition of *A. dryopteroides* and the bipinnate-pinnatifid condition of *N. portoricensis* (Fig. 6). The stem, petiole and rachis of the hybrid have a few spines reaching 2.5 mm. long (Figs. 9 and 10), a condition which is intermediate between the spineless *A. dryopteroides* (Figs. 7 and 8) and the numerous spines reaching 5.5 mm. long in *N. portoricensis* (Figs. 11 and 12). The hybrid has from 18-25 leaf scars 1.5 cm. in diameter, per 10 cm. of stem (Fig. 9). *Alsophila dryopteroides* has about 43 leaf scars 1.0 cm. in diameter, per 10 cm. of stem (Fig. 7) while *N. portoricensis* has about 13 leaf scars 2.0 cm. in diameter, per 10 cm. of stem (Fig. 11).

One character of the hybrid is similar to that of *Alsophila dryopteroides*. The dark lanceolate laminar scales with a single apical seta found in the hybrid (Fig. 14) closely resemble the most prominent laminar scale of *A. dryopteroides* (Fig. 13).

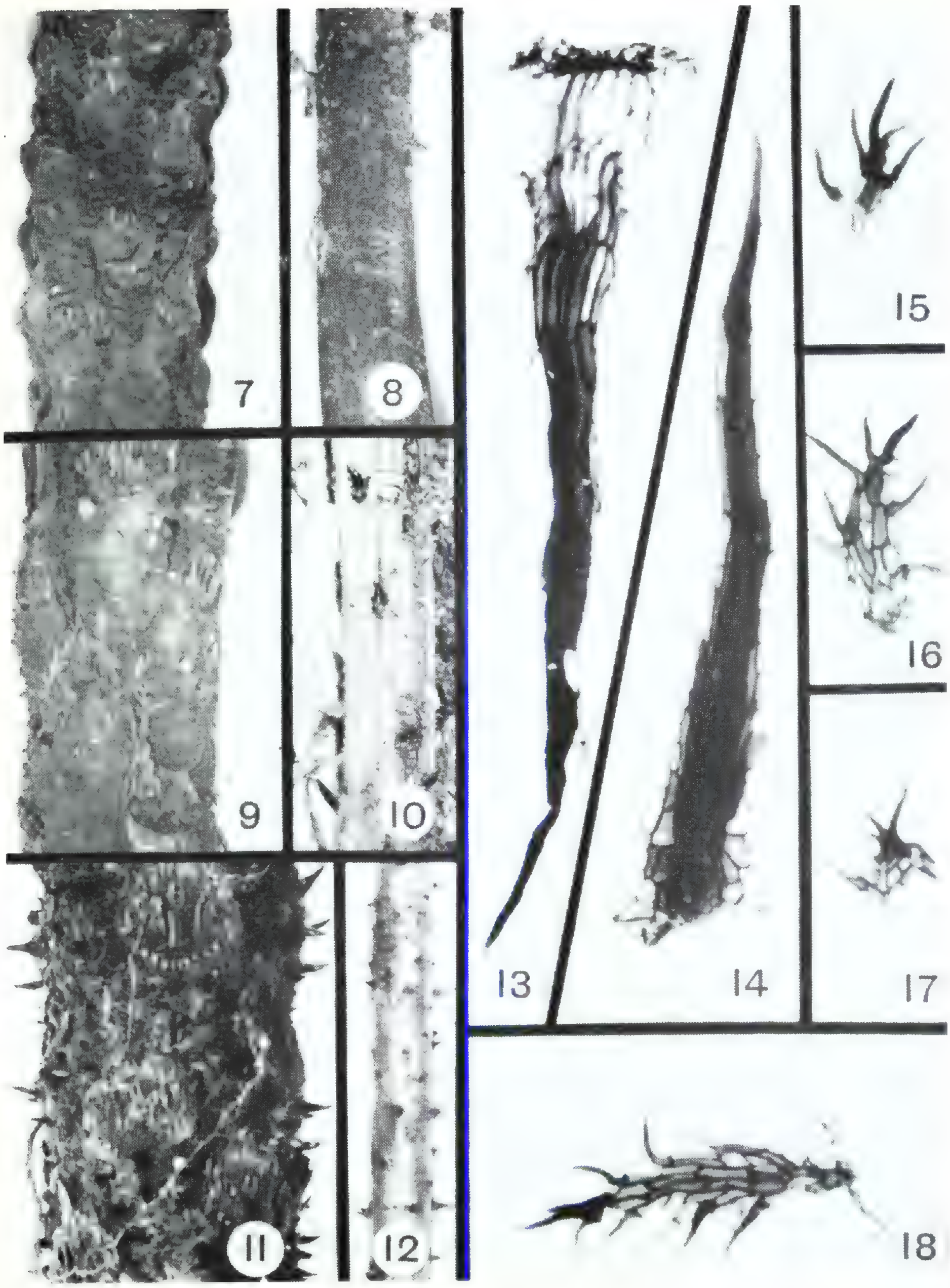
Other characters of the hybrid are like those of *Nephelea portoricensis*. The acaroid type of laminar scale occurs in both the hybrid (Fig. 15) and in *N. portoricensis* (Fig. 17) and the marginally setate type of scale also occurs in the hybrid (Fig. 16) and in *N. portoricensis* (Fig. 18).

The spores of the hybrid plants are well developed (Fig 2). A study of their viability has been planned but until it is completed it is not possible to suggest the number of F_1 hybrids probably involved in the five plants seen.

Trunk erect, occasionally short spiny, to 2 m. high, leaf scars 1.5 cm. in diameter, 18-25 per 10 cm. of stem length. Leaves 1.0-1.5 m. long, petiole to 10 cm., armed with short black squaminate spines; lamina lance-ovate, gradually narrowed at base (basal pinnae to ¼ as long as the median), to 60 cm. broad at the middle, acuminate, bipinnate-lobed to occasionally bipinnate-pinnatifid, leaf tissue glabrous,

Table 1. Character comparison of *Alsophila dryopteroides*, *Nephelea portoricensis*, and their hybrid.

Alsophila dryopteroides	Hybrid	*Nephelea portoricensis*
stem to 0.5 m., spineless	stem to 2.0 m., occasionally with short spines	stem to 4.0 m., with many long spines
leaf scar number ca. 43 per 10 cm. of stem length	leaf scar number 18-25 per 10 cm. of stem length	leaf scar number ca. 13 per 10 cm. of stem length
leaf scars 1.0 cm. in diameter	leaf scars 1.5 cm. in diameter	leaf scars 2.0 cm. in diameter
leaves to 1.0 m. long	leaves to 1.5 m. long	leaves to 2.0 m. long
petiole spineless	petiole with short squaminate spines, especially on the persistent base	petiole with long squaminate spines throughout
lamina oblanceolate	lamina lance-ovate	lamina ovate
pinna number to 40	pinna number to 25	pinna number to 13
basal pinnae reduced to auricles	basal pinnae ¼ the length of median ones	basal pinnae only slightly shorter than median ones
pinna-rachis undersurface without trichomes	pinna-rachis undersurface with a few trichomes	pinna-rachis undersurface with many trichomes
dark lanceolate laminar scales with single apical seta present	dark lanceolate laminar scales with single apical seta absent	dark lanceolate laminar scales with single apical seta absent
acaroid laminar scales absent	acaroid laminar scales present	acaroid laminar scales present
marginally setate laminar scales absent	marginally setate laminar scales present	marginally setate laminar scales present



Figs. 7-18. *Alsophila dryopteroides*, *Hybrid*, and *Nephelea portoricensis*. Figs. 7-8. *A. dryopteroides:* 7, stem, × 2/3, *Conant* 682, 8, petiole, × 2, *Conant* 690. Figs. 9-10. *Hybrid:* 9, stem, × 2/3, *Conant* 680, 10, rachis, × 2, *Conant* 680. Figs. 11-12. *N. portoricensis:* 11, stem, × 2/3, *Tryon & Tryon* 6950, 12, petiole, × 2/3, *Conant* 412. Fig. 13. *A. dryopteroides*, lanceolate type scale, × 100, *Conant* 598. Figs. 14-16. *Hybrid:* 14, lanceolate type scale, × 100, *Conant* 687, 15, acaroid scale, × 100, *Conant* 687, 16, marginally setate scale, × 100, *Conant* 687. Figs. 17-18. *N. portoricensis:* 17, acaroid scale, × 100, *Conant* 188, 18, marginally setate scale, × 100, *Conant* 188. (all specimens GH).

herbaceous, glaucescent beneath, dark green above; rachis dull castaneous, occasionally with short spines at the base, glabrescent to squamulose beneath, invested with stiff, brown, antrorse trichomes and a few long filiform scales above; pinnae to 25, spreading, sessile, the largest 30 cm. long, 7 cm. broad near base, becoming pinnatifid towards the apex; pinna-rachis beneath invested with marginally setate scales, acaroid scales, and dark bodied, light margined, lanceolate scales with a single, dark, stout apical seta, and with intermediate scales ranging from oblong to lanceolate, uniformly brown to dark bodied, and many setate to singly and stoutly setate, these latter types becoming sub-bullate towards the apex; undersurface of pinna-rachis becoming sparsely pubescent apically; pinnules 18-24 pairs, 19-34 mm. long, 7-10 mm. broad, deeply lobed to occasionally pinnatifid at the base; costa beneath often with acaroid scales at the base, and beyond with sub-bullate scales with few to many setae, these progressing to bullate scales at the pinnule apex, occasionally with a few stiff trichomes apically; costules with marginally setate sub-bullate scales at the base, these grading into squamules apically; veins 4-5 pairs, sori 2-3 on each lobe, closer to the costule than to the margin; indusia deeply cyathiform, tan, membranous, glabrous; spores well developed, light tan. trilete.

SPECIMENS EXAMINED:

Puerto Rico: Five plants from the vicinity of Cerro de Punta, 40 miles w.s.w. of San Juan, ravine on north side of road, Rt. 143, km. 18.5 e. of jct. with Rt. 10, *Conant* 678 (GH, NY, US), *Conant* 679 (GH, NY, US), *Conant* 680 (GH, NY, US), *Conant* 687 (F, GH, IJ, NY, RPPR, US, USD, Herb. El Verde Field Station, Puerto Rico); ravine on north side of road, Rt. 143, km. 22.2 e. of jct. with Rt. 10, *Conant* 599 (GH).

2. **Cnemidaria horrida** (L.) Presl × **Cyathea arborea** (L.) Sm. *Hemitelia Wilsonii* Hook. in Hook. & Baker, Syn. Fil. 30. 1865. TYPE: Jamaica, *Wilson* 731 (K). (See Maxon, Contrib. U.S. Nat. Herb. 17: *t. 18.* 1914.)

The status of *Hemitelia Wilsonii* (Fig. 3) as a species is untenable because well developed spores have not been found in its sporangia. Other factors indicating a hybrid status are the highly variable leaf architecture and the variable venation.

I have seen *Hemitelia Wilsonii* growing at two sites in the Luquillo Forest, 20 miles e.s.e. of San Juan, Puerto Rico (Rt. 186, km. 19.0 s. of jct. with Rt. 3, Municipio de Rio Grande, and Sabana Rd., km. 3.0 e. of jct. with Rt. 191, Municipio de Rio Grande). In both places *Cnemidaria horrida* and *Cyathea arborea* were growing nearby.

The hybrid is intermediate between the parental species in its venation, indusia, and leaf architecture. The venation of the hybrid is usually free but occasionally anastomoses or forms loops or dead-ends or both (Fig. 22). This condition is intermediate between the free venation of *Cyathea arborea* (Fig. 24) and the anastomosing venation of *Cnemidaria horrida* (Fig. 20). The indusia of the hybrid range from hemiteloid to sub-cyathiform (Fig. 21), a condition intermediate between the hemiteloid indusia of *Cn. horrida* (Fig. 19) and the cyathiform indusia of *C. arborea* (Fig. 23). The leaf architecture of the hybrid ranges from bipinnate-lobed to bipinnate-pinnatifid. This is intermediate between the pinnate-pinnatifid condition of *Cn. horrida* and the bipinnate-pinnatifid to tripinnate architecture of *C. arborea*.

Characters of the hybrid which are closest to *Cnemidaria horrida* are the shape of the pinna and leaf apex and the bicolorous scales on the croziers and petioles (Fig. 4). One character of the hybrid which is found in *Cyathea arborea* but not in *Cn. horrida* is the small whitish scales on the costa undersurface.

The apparent absence of viable spores, the combination of characters, and the documented occurrence of *Hemitelia Wilsonii* in the vicinity of both parental species, support the proposal of *H. Wilsonii* as a hybrid between *Cnemidaria horrida* and *Cyathea arborea*.

Figs. 19-24. *Cnemidaria horrida*, *Hybrid*, and *Cyathea arborea*. Figs. 19-20. *Cn. horrida:* 19, indusia, × 20, *Gastony* et al. 655, 20, venation, × 7½, *Scamman* 8117. Figs. 21-22. *Hybrid:* 21, indusia, upper arrow, subcyathiform indusium, lower arrow, hemiteloid indusium, × 20, *Gastony* et al. 654, 22, venation, upper arrow, anastomosing veins, middle arrow, space between free veins (note loop in lower vein), lower arrow, dead-end in vein, × 7½, *Conant* 546. Figs. 23-24. *C. arborea:* 23, indusia, × 20, *Howard & Nevling* 15776, 24, venation, × 7½, *Gastony* 10. (all specimens GH).

SPECIMENS EXAMINED:

Puerto Rico: *Conant* 546, 626, 627 (GH), *Hess* 371 (NY), *Hioram* 182, 804 (NY), *Kepler*, Sabana Rd., El Yunque Rd., 5 Mar., 1970, Herb, El Verde Field Station, Municipio de Rio Grande. **Dominican Republic:** *Abbott* 2660 (GH, NY, US), *Ekman* 14752 (NY), 15014 (GH, NY), *Gastony, Jones & Norris* 654 (GH). **Haiti:** *Ekman* H4835 (NY, S), H4846 (S, US). **Jamaica:** *Jenman* (NY), *Proctor* 18419 (A).

PUTATIVE HYBRIDS

The establishment of the *Alsophila-Nephelea* intergeneric hybrid with a bipinnate-lobed leaf architecture helps to interpret other rare species and unusual collections with a similar architecture within the *Alsophila-Nephelea* evolutionary line. These are discussed below in order of the certainty of their parental species. All of them combine characters of species with very different leaf architecture and (or) lamina indument. All are very rare, known mostly from one collection, and do not fit within the variation of the species proposed as parents. *Nephelea cinna* may be a hybrid, perhaps between *N. pubescens* and *N. Tussacii* as suggested by Gastony (1973) but a detailed analysis of it has not been made.

3. **Alsophila Brooksii** (Maxon) Tryon × **Nephelea portoricensis** (Kuhn) Tryon

A collection from Indiera Fria, near Maricao, Puerto Rico (*Britton, Cowell, & Brown* 4520 (NY)) resembles the *Alsophila dryopteroides* – *Nephelea portoricensis* hybrid quite closely in leaf dissection and in width to length proportions of the pinnae and pinnules. It differs in that it lacks the dark bodied, light margined, lanceolate scales with a single, dark, stout apical seta of *A. dryopteroides*. In addition the lamina base is abruptly narrowed, and the petiole is up to 25 cm. long. The complexity of the lamina, the abundance of acaroid scales, and the pubescence of the veins and costules of this collection are all characters attributable to *N. portoricensis* as pointed out by Gastony (1973). The unusually long and narrow pinnae suggest that this may be a hybrid involving *N. portoricensis* and

an *Alsophila* species with a less dissected lamina and long narrow pinnae. *Alsophila Brooksii* is well known from the Maricao Forest about 10 km. to the west of Indiera Fria. It is the only species of *Alsophila* occurring in the western end of the island, and it has a pinnate-pinnatifid lamina abruptly reduced at the base. It has long narrow pinnae and its petiole reaches 78 cm. in length. Its characters, combined with those of *N. portoricensis*, would result in a plant very similar to the *Britton et al.* 4520.

4. **Nephelea balanocarpa** (D. C. Eaton) Tryon × **Nephelea woodwardioides** (Kaulf.) Gastony

Cuban material with bipinnate-lobed lamina architecture such as *Leon, Clement, & Roca* 10533 (NY) and *Hioram & Clement* 6377 (US) seems to represent hybrids between pinnate-pinnatifid and bipinnate-pinnatifid species. One parent is probably the bipinnate-pinnatifid *Nephelea woodwardioides*. It is not clear whether var. *woodwardioides* or var. *cubensis* (Maxon) Gastony is involved. *Nephelea balanocarpa* is probably the second, pinnate-pinnatifid parent. It is far more common than *A. Brooksii*, also *pinnate-pinnatifid*, which is known in Cuba only from the type collection. The abundance of tiny antrorse squamules covering the veins in the hybrid is in agreement with the indument of *N. balanocarpa*.

5. **Alsophila hotteana** (C.Chr. & Ekman) Tryon × **Nephelea sp.** *Cyathea confinis* C. Chr. Kungl. Svensk. Vetens.-akad. Hand. ser. 3, **16**:13. 1937. TYPE: Haiti, Massif de la Hotte, Jeremie, *Ekman* 10382 (holotype, S; isotype, US!).

Cyathea confinis, a Haitian species known only from the type collection at Massif de la Hotte, has a bipinnate-lobed lamina, suggesting that it is probably of hybrid origin. It is described as having an aculeate trunk to 2 m. high, a short petiole armed with short black spines, and a gradually reduced lamina base. A relationship to the genus

Nephelea is evident in the aculeate trunk and the black petiole spines. Three species of the genus occur in Haiti, *N. crassa* (Maxon) Tryon, *N. fulgens* (C.Chr.) Gastony, and *N. woodwardioides* (Kaulf.) Gastony var. *Hieronymi* (Brause) Gastony. All are tall and have a bipinnate-pinnatifid lamina making it difficult or impossible to determine from herbarium specimens which of the species is involved in the cross.

Alsophila hotteana is probably the pinnate-pinnatifid parent. Its short petiole, gradually narrowed lamina base, and tall stem are consistent with the characters required of the second parent, and it is the only *Alsophila* known to occur in the Massif de la Hotte. Other species of *Alsophila* in Haiti are restricted to the Massif du Nord.

Putative Hybrids Involving Undetermined Species of Alsophila and Nephelea

6. *Cyathea irregularis* Brause Urban Symb. Ant. 7. 155. 1911. TYPE: Dominican Republic, Santo Domingo, Constanza, *Turckheim* 3212 (holotype, B; isotype, NY!).

Cyathea irregularis, known only from the type collection, is another species with a bipinnate-lobed lamina. It is evidently a hybrid of *Alsophila* and *Nephelea* since all species of *Alsophila* in the Dominican Republic are pinnate-pinnatifid and all species of *Nephelea* are bipinnate-pinnatifid. The single specimen of a midportion of the lamina, however, provides too few characters to choose between the four Alsophilas and three Nepheleas known to grow in the country.

Another specimen from the Dominican Republic, with a similar leaf morphology, *Abbott* 2031 (US, pro parte) is probably an *Alsophila* × *Nephelea* hybrid but may not have the same parents as *Cyathea irregularis*.

7. *Cyathea jamaicensis* Jenm. Jour. Bot. **20**: 323. 1882. TYPE: Jamaica, Mansfield, near Bath, *Wilson* 686 (holotype, BM; isotype, GH!).

The bipinnate-lobed *Cyathea jamaicensis* is known only from the type collection. It is similar to *Nephelea concinna*, but may be separated from it by its pinna rachis indument and by its indusium. *Cyathea jamaicensis* has the undersurfaces of its pinna-rachises nearly without scales and trichomes and it has a meniscoid indusium. *Nephelea concinna* has its pinna-rachis undersurfaces quite well invested with scales and trichomes and it has a cyathiform to urceolate indusium. Also, *C. jamaicensis* is described as having an unarmed stem whereas *N. concinna* has a spiny stem.

It seems probable that *Cyathea jamaicensis* is a hybrid because of its lamina architecture and its rarity. The lack of spines on its trunk implies that it could not be an intrageneric cross involving two species of *Nephelea*. The degree of lamina dissection of *C. jamaicensis* suggests that a bipinnate-pinnatifid species of *Nephelea* has crossed with a pinnate-pinnatifid species of *Alsophila*.

CONCLUSIONS

Two certain and five putative hybrids have been proposed. All combine characters of species with very different leaf architecture, lamina indument, and (or) indusia. The implication is that other species with similar leaf architecture, lamina indument, and (or) indusia should also cross. These hybrids would be very difficult or impossible to detect. Some polymorphic species in current taxonomic treatments may require reassessment because hybrids may have been included in the taxa. Careful field observations of species that are growing together, whenever tree fern collections are made, will help to solve this problem.

The presence of well developed spores in the *Alsophila dryopteroides* × *Nephelea portoricensis* hybrid suggests that these genera are closely related. The apparent absence of well developed spores in the *Cnemidaria horrida* × *Cyathea arborea* hybrid implies a more distant relation of the parents.

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ZOSTERA MARINA L., ITS GROWTH AND DISTRIBUTION IN THE GREAT BAY ESTUARY, NEW HAMPSHIRE[1]

STANLEY A. RIGGS, JR. AND RICHARD A. FRALICK[2]

Protected coastal and estuarine waters of New England often contain dense meadows of the marine Angiosperm *Zostera marina* L. Little was known of the ecology of *Zostera*, or eel grass as it is commonly called, until a wasting disease attributed to the parasitic marine fungus *Labyrinthula* almost exterminated the *Zostera* population in New England waters (Jepps, 1931; Renn, 1934, 1935, 1936a, 1936b; Young, 1937, 1943).

The present paper compares the seasonal growth (biomass), reproductive phenology, and local distribution of *Zostera* with seasonal variations in temperature and salinity. The results of vertical and horizontal transplants are discussed as well as the possibility of ecotypical adaptation.

METHODS AND MATERIALS

Bimonthly observations and measurements of *Zostera marina* populations were made at eight stations within the Great Bay estuary system during 1972 (Table 1). Measurements of surface water temperature and salinity were made at mean low water (MLW). Biomass was also recorded at MLW since the majority of *Zostera* plants occurred in this zone.

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Table 1. Characteristics of eight stations within the Great Bay Esturary.

Stations/ nautical miles inland		Temperature °C		Salinity ‰	Substrate
1. Jaffrey Point (0.0)	avg.	10.2	avg.	30.3	rocky outcrops
	max.	23.0	max.	32.5	with some sand
	min.	1.0	min.	26.0	
2. Pierce Island (2.0)	avg.	10.5	avg.	27.0	broken rocks, mud
	max.	21.5	max.	32.0	and silt
	min.	0.0	min.	19.0	
3. Newington Town Landing (5.5)	avg.	11.7	avg.	24.5	small rocks, mud
	max.	24.0	max.	31.0	and silt
	min.	0.4	min.	16.0	
4. Dover Point (7.0)	avg.	12.5	avg.	23.7	large rock outcrop-
	max.	25.0	max.	32.0	pings, mud and silt
	min.	3.0	min.	15.0	
5. Cedar Point (8.3)	avg.	13.6	avg.	22.1	mud and silt
	max.	27.0	max.	32.0	
	min.	0.0	min.	6.0	
6. Adams Point (10.7)	avg.	13.8	avg.	21.0	rock outcroppings,
	max.	28.0	max.	31.5	shale, cobble,
	min.	0.5	min.	8.0	mud and silt
7. Chapmans Landing (15.2)	avg.	14.2	avg.	5.7	mostly mud,
	max.	26.5	max.	22.0	some small
	min.	0.0	min.	0.0	rocks and boulders
8. Exeter (19.1)	avg.	14.4	avg.	3.4	mud and silt
	max.	28.1	max.	20.0	
	min.	0.0	min.	0.0	

Growth studies were initiated during March, 1972. Tagged plants (approximately 100) were established at Stations 2 through 6, and the blade length was measured according to the method of McRoy (1970). Horizontal and vertical transplants of *Zostera* were also initiated in March, and the plants were subsequently observed and measured for a period of 10 months. Each of the transplants was duplicated, one using the substrate of the original station and the other using the substrate of the new station.

McRoy (1970) showed that a rapid estimate of the standing crop of *Zostera* is possible because of a relationship between blade length and dry weight. By incorporating both the width and the length of the blades we derived and untilized the following equation for conversion to dry weight (biomass) without harvesting or damaging the plants.

Formula Example:

$$Y = (0.308 \times 10^{-4})\ (x) - 48.2 \times 10^{-4}$$

$Y =$ dry wt. (grams)

$x = L \times W$ (mm)

blade width $= 5$ mm

blade length $= 100$ mm

$L \times W = 500$

$$Y = (0.308 \times 10^{-4})\ (500) - 48.2 \times 10^{-4}$$

predicted $- 10.6 \times 10^{-3}$ g dry wt.

actual $- 10.8 \times 10^{-3}$ g dry wt.

A linear regression was performed between the predicted dry weight and the actual dry weight, and a correlation coefficient of 0.99 was obtained.

Temperature was recorded with a laboratory grade, submersible, mercury thermometer. Salinity was determined with a set of hydrometers (G.M. Manufacturing Co., N.Y.) and the readings were corrected to 15°C.

Hydrographic factors: Figure 1 shows the seasonal variation in temperature at two representative stations for 12 months. Stations 1 and 2 exhibited similar temperature values with maximum temperatures of 23.0° and 21.5° C occurring in July and minimum temperatures 1° and 0° C occurring in January, February, and December. Stations 3 and 4 exhibited maximum temperature values of 25.0° to 26.0° C in July with minimum values of 0° C during the winter months. Stations 6, 7, and 8 showed the greatest ranges in temperature with maximum values of 27.5° C in July and minimum values of 0° C in January, February, and December.

FIG. 1

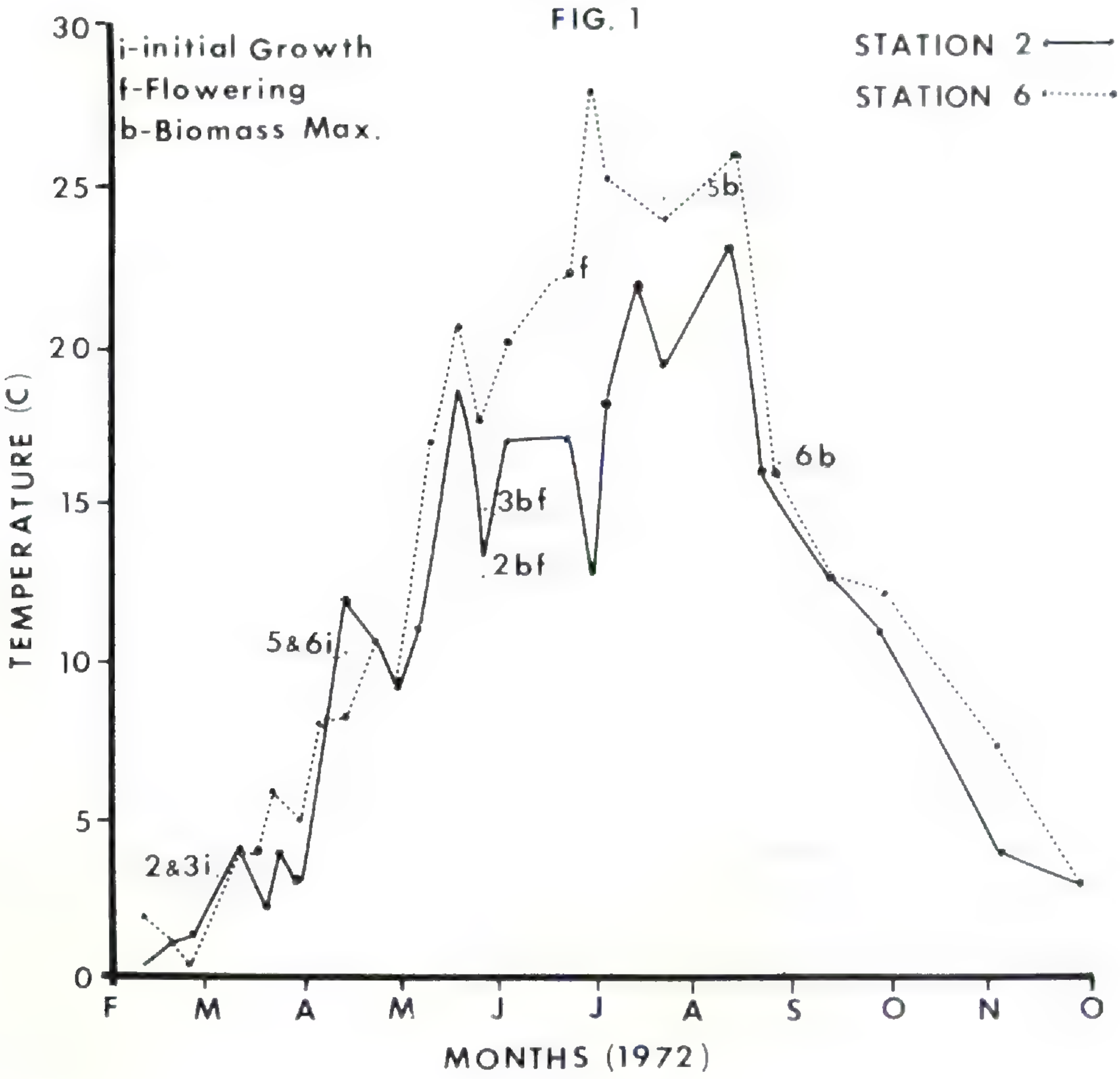
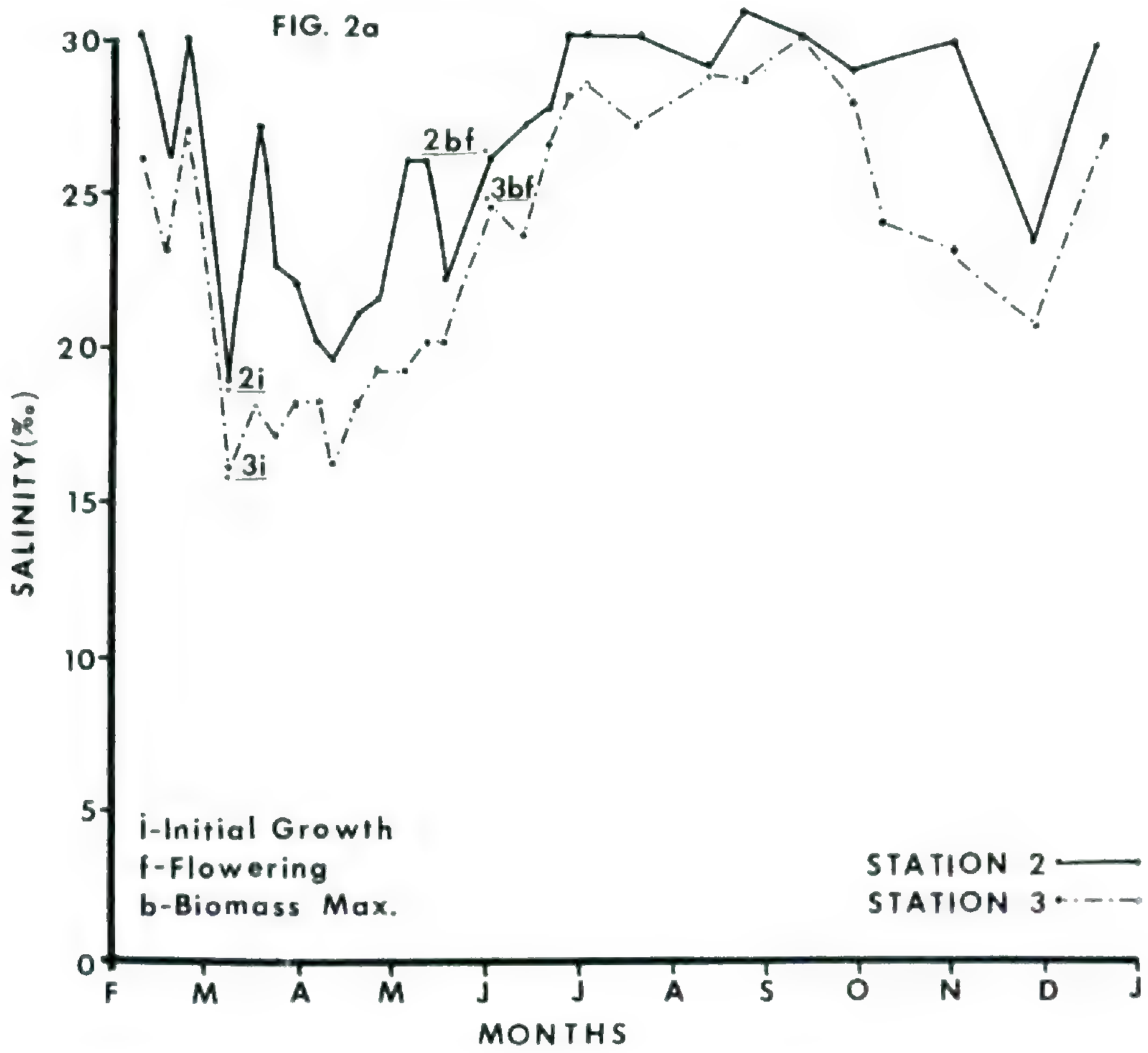
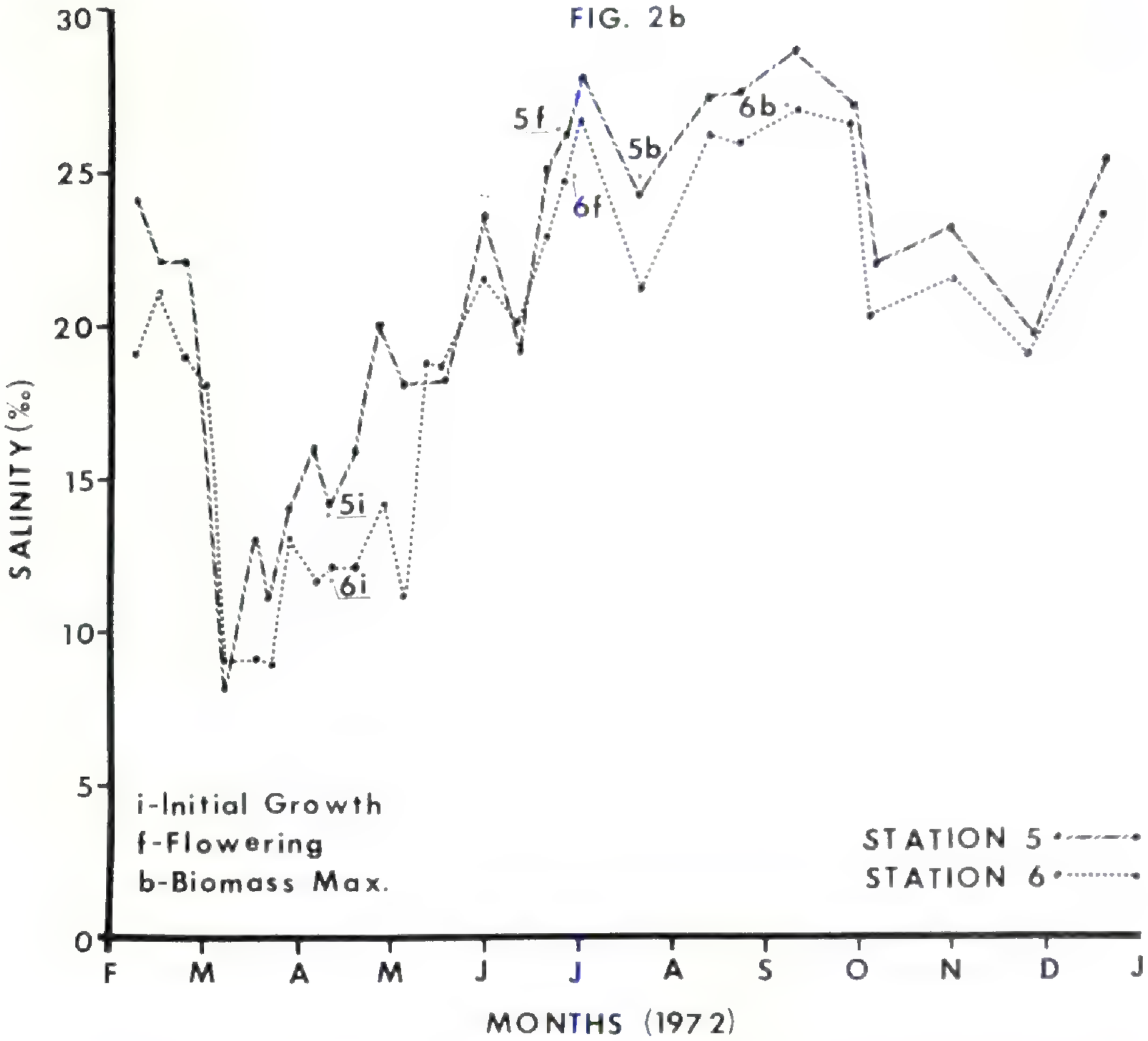


Figure 2 shows the seasonal variation of salinity at four representative stations for 12 months. The values are consistent with the proximity of each station to the open coast. Thus, Station 1 had a seasonal salinity range of 26.0 to 32.5 o/oo.; Station 2 showed a range of 19.0 to 32.0 o/oo.; Station 6 had a range of 8.00 to 21.0 o/oo., while Station 8 had the lowest salinities within a range of 0.0 to 20.0 o/oo.



Seasonal growth: Figure 3 indicates that active growth of *Zostera* was initiated during March and April at Stations 2, 3, 5, and 6. The plants at Stations 2 and 3 exhibited a conspicuous elongation of the blades (1 to 3 cm) in March. The plants at Stations 5 and 6 did not initiate growth until the end of April. Growth at Stations 2, 3, 5, and 6 declined rapidly during November and December and no growth was recorded in January and February. No

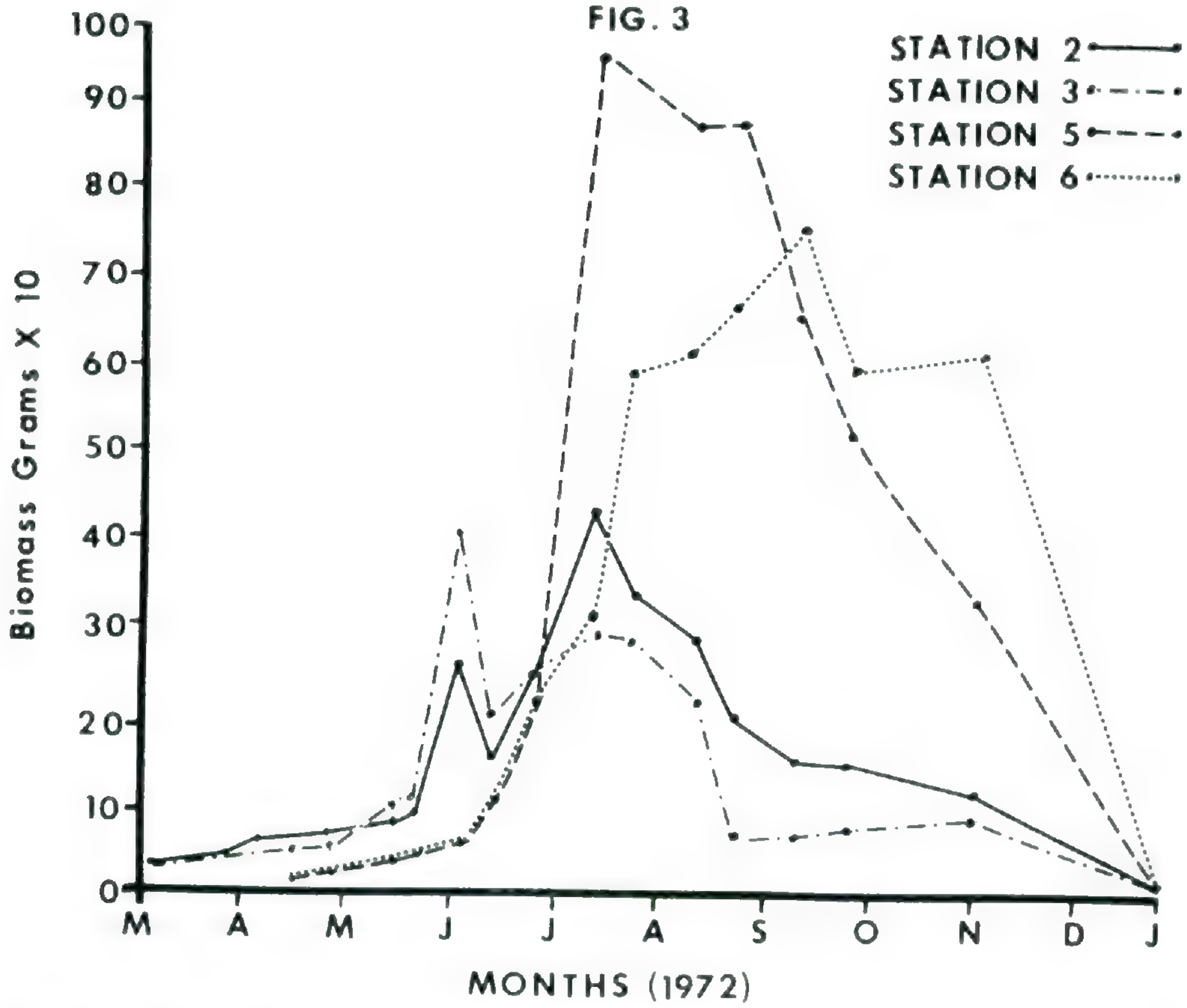
FIG. 2b



growth was observed at Stations 1, 7, and 8 throughout the season. The growth at Station 4 is not illustrated because the colony was considered subtidal, while all other stations were intertidal.

Standing crop: Figure 3 illustrates the seasonal variation in standing crop of *Zostera* at several stations. Minimum values were apparent from December through March. Maximum standing crop values were recorded in August at Station 5. The plants at Station 6 reached their maximum biomass in late September. Two peaks were evident at Stations 2 and 3; the first occurred in mid-June and the second in early August. The initial peak in biomass was associated with flowering, while a decrease in early July was attributed to the abscission of floral parts. In some

FIG. 3

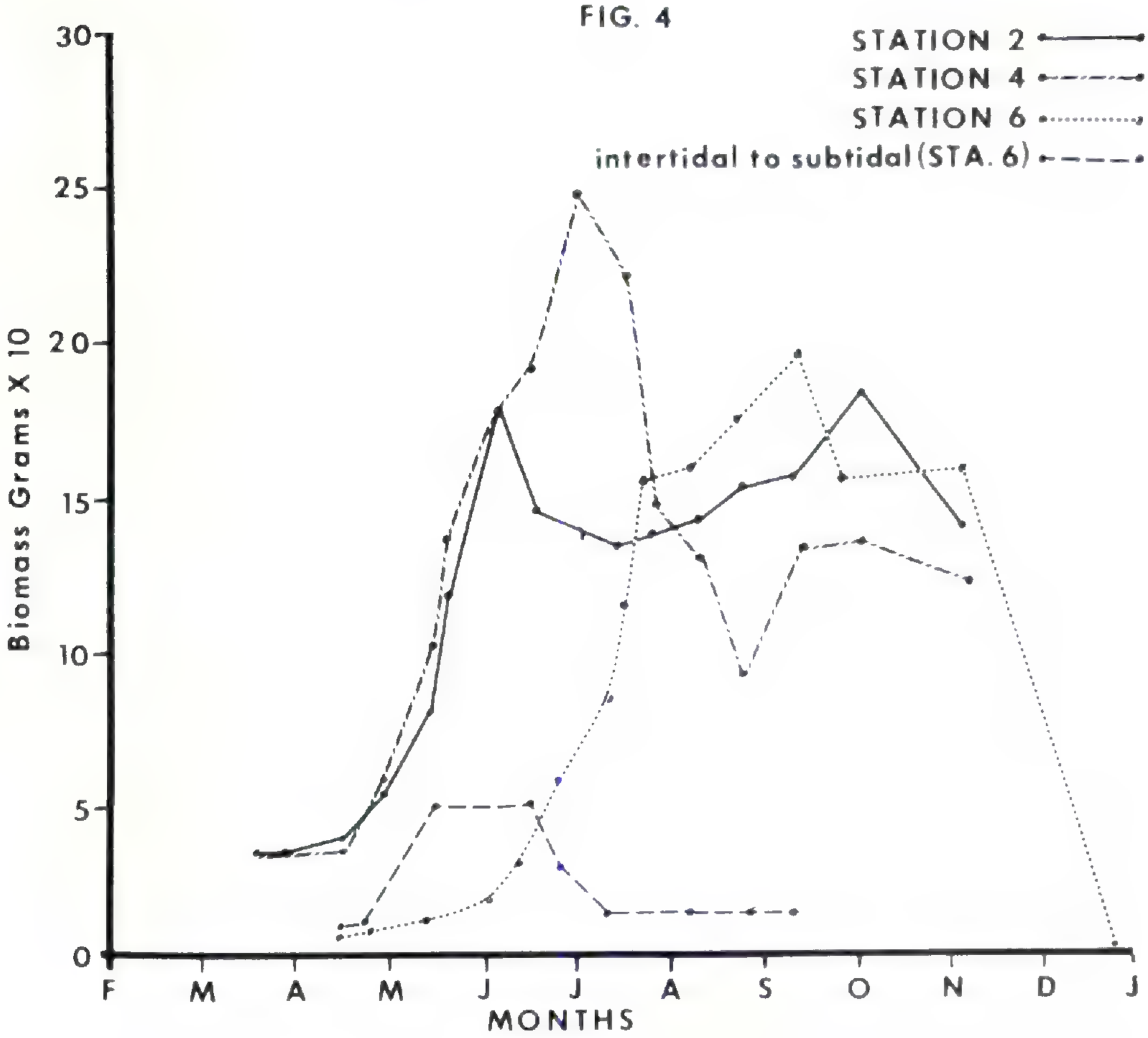


cases vegetative turions without reproductive parts remained intact and continued to grow.

A general decline in standing crop was apparent at nearly all stations by late September, and although some growth continued until December, no significant increase in biomass was recorded at any station after October. The process of floral abscission was not apparent at Station 6 until early October.

Horizontal transplants: Transplants were also initiated between various stations during the spring. In all cases the plants showed their maximum standing crop values at the same time as the original populations from which they were derived. For example, *Zostera* transplanted from station 2 to 6 reached a maximum standing crop value in mid-June, while the original material at Station 6 did not peak until late September (Fig. 4). *Zostera* at Station 4 reached a maximum standing crop value in July.

FIG. 4



Transplants of *Zostera* plants (9.0 to 16.0 cm long) from Station 2 to 8 died within a week. Differential responses to transplanting were observed when smaller plants (2.0 to 8.0 cm long) survived a transplant between the same stations for more than 30 days.

DISCUSSION

Within the Great Bay Estuary system, *Zostera* first initiated growth, flowered, and reached maximum biomass at the stations nearest the coast. Stations further up in the estuary initiated growth, flowered, and reached a maximum biomass some three months later than stations close to the coast.

The initial growth of *Zostera*, in contrast to Setchell's 1929 findings, is neither restricted to a specific 5 degree

temperature isotherm, nor to temperatures greater than 10° C. Although *Zostera* has been observed living beneath winter sea ice (McRoy, 1969), to our knowledge its growth has not previously been measured at temperatures below 10° C.

The initial period of maximum biomass did not appear to be related to any specific temperature range. Thus, plants at Stations 2 and 3 reached their maximum biomass at 18° C, while it was attained at 25° C at Station 5 and 16° C at Station 6.

The flowering period is not restricted to a specific temperature isotherm (15° to 20° C) as suggested by Setchell, 1929. *Zostera* flowered in the spring at Stations 2 and 3 when the temperatures were about 17.0° C. At Station 6 flowering did not take place until fall despite an increase in temperature up to 28.0° C.

There was a correspondence between peak biomass and high salinity at each site. Thus, *Zostera* plants at Stations 2 and 3 reached their first maximum biomass at salinities of 26.0 o/oo and 24.0 o/oo respectively, while maximum biomass at Station 5 was reached at a salinity of 25.0 o/oo — 40 days later than at Station 2. *Zostera* plants at Station 6 reached maximum biomass at a salinity of 27.0 o/oo, in September, nearly 100 days later than at Stations 2 and 3.

The time of flowering was also correlated with salinity. Thus, *Zostera* plants at Stations 2 and 3 initiated flowering when the salinities were 26.0 and 24.0 o/oo. The plants at Stations 5 and 6 also initiated flowers at the same salinities, but approximately three weeks later than at Stations 2 and 3.

It appears that *Zostera marina* maintains its original growth patterns even after being transplanted to new locations. Thus, transplants from Stations 2 and 4 to 6 followed a pattern of growth and development similar to that of the plants in their original colony. In no case did transplanted *Zostera* follow a sequence of growth and phenological development parallel to patterns in plants originating in the new location.

The horizontal transfer of *Zostera* colonies within the estuary had no noticeable effects on their development. Vertical transplants (intertidal to subtidal) frequently showed a decrease in their rate of development. Thus, when young seedlings (1 to 3.0 cm long) were transplanted vertically their development was conspicuously slowed (Fig. 4). In contrast, transplants from the subtidal to the intertidal zone were consistently successful. Transplants to brackish waters with salinities of 4.0 to 5.0 o/oo did poorly. The greatest level of success in transplants to brackish water occurred when plants 3 cm or less in length, originating at stations close to the brackish water, were transplanted with their rhizomes intact.

A distinct potential for vegetative propagation was obvious throughout our transplant studies. In most cases transplants of individual *Zostera* plants responded favorably. The only exception occurred with transplants from intertidal to subtidal locations.

A lack of clear correlation was evident between the onset of the plants' various phenological phases and temperature. However, there was some indication that the onset of various phenological stages may be, in part, related to moderate salinity ranges of 24 to 27 o/oo. In all instances, phenological development started in plants nearer the open coast and progressed up the estuary. A tendency of *Zostera* to form ecotypes between stations which differed in their seasonal salinity patterns was obvious. However, further studies to determine the effects of temperature related salinity tolerances may be warranted. McMillan (1956) has noted a tendency for some Graminae to adapt towards different habitats. In addition Biebl and McRoy (1971) have noted that *Zostera* may exhibit a physiological adaptation to a particular environment. This fact was obvious in our investigations because *Zostera* could be collected in distinctly subtidal habitats at depths as great as 6 meters. Since there is no possibility of these plants ever being exposed to the atmosphere, we consider them to be good examples of adaptation to a subtidal existence.

Our results indicate that *Zostera marina* may undergo successful ecotypical adaptation toward a particular environment. This adaptation is probably more closely related to moderate salinities than specific temperatures. We also have shown that transplants of *Zostera* between habitats is feasible.

The mathematical formula employed in this investigation proved to be an accurate method of assessing biomass for *Zostera* without harvesting the plants.

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OBSERVATIONS ON BATRACHOSPERMUM (RHODOPHYTA) IN SOUTHEASTERN WISCONSIN STREAMS

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Knowledge of the genus *Batrachospermum* (Rhodophyta) in Wisconsin stems mainly from the report of Prescott (1951) who records four species from lotic environments without reference to locality and with only scant ecological data. Moreover, information on seasonal periodicity and environmental conditions of the type obtained by Dillard (1966) in North Carolina, Minckley and Tindall (1963) in Kentucky, and Rider and Wagner (1972) in Pennsylvania apparently is lacking for Wisconsin. (The last reference includes a literature review of *Batrachospermum* ecology.)

The present investigation has been undertaken to gain information on 1) the occurrence of *Batrachospermum* in southeastern Wisconsin streams and 2) the environmental conditions present at localities where this taxon grows. During the course of the study 201 randomly selected stream localities have been visited; *Batrachospermum* plants occurred at 13 or 6.4% of these sites.

MATERIALS AND METHODS

At each station (Table 1) where *Batrachospermum* plants were found, chemical and physical data on alkalinity, carbon dioxide, hardness (calcium and total), nitrate nitrogen, orthophosphate, oxygen, pH, temperature, and turbidity have been gathered using a Hach Water Analysis Field Kit, model DR-EL, which employs microadaptations from the "Standard Methods" handbook (American Public Health Association 1965). In addition, some observations on the type of substrate, relative current velocity, and relative exposure to sunlight have been made.

At stations where *Batrachospermum* populations persisted for extended periods, observations were made at 4-6 week intervals for 10-11 months to note any seasonal changes.

TABLE 1

LIST OF *BATRACHOSPERMUM* LOCALITIES, DATES SAMPLED, AND LOCALITY ABBREVIATIONS USED IN TEXT DISCUSSION

Text Abbreviation	County	Locality	Dates
B	Walworth	Bluff Ck, T4N, R15E, S23 at Co. Hwy P crossing	7.VI.1972
BE	Dane	Black Earth Ck, T7N, R7E, S2 along U.S. Hwy 14	15.VII.1972, 12.XI.1972, 9.i.1973
F	Walworth	"Fontana Ck", T1N, R16E, S11 at St. Hwy 67 crossing	7.VI.1972, 11.VII.1972, 3.XII.1972, 7.I.1973, 3.II.1973, 10.III.1973, 17.IV.1973
J	Manitowoc	Jumbo Ck, T21N, R23E, S26 at unnamed town road crossing	22.VII.1972
K	Sauk	Koshwego Springs, Devils Lk. St. Pk, T11N, R6E, S23	31.V.1972, 5.VII.1972, 9.XI.1972, 6.XII.1972, 5.I.1973, 9.II.1973, 10.III.1973, 17.IV.1973
M	Dane	Merrill Springs, Lk. Mendota, Madison, T7N, R9E, S18	11.V.1972

TABLE 1 cont.

MC	Iowa	Mill Creek, T7N, R3E, S35 at Twin Valley Lks. Road	3.VII.1972
N	Sheboygan	Nichols Ck, T14N, R21E, S18, at Cedar Lane Rd Crossing	23.VII.1972
Q	Washington	Quas Ck, T11N, R19E, S25 at U.S. Hwy 45 junct with Co. Hwy. NN	15.VI.1972
SC	Waukesha	Scuppernong Ck, T6N, R17E, S36 at U.W. Field Station near Waterville	5.VI.1972, 10.VII.1972, 5.VIII.1972, 17.IX.1972, 4.XI.1972, 2.XII.1972, 6.I.1973, 4.II.1973, 3.III.1973, 16.IV.1973
SR	Waukesha	Scuppernong R., T6N, R17E, S34, near junct of St. Hwy 67 and Co. Hwy 22	5.VI.1972, 7.VII.1972, 5.VII.1972, 17.IX.1972, 2.II.1973
SS	Waukesha	Scuppernong Spring, T5N, R17E, S3 along St. Hwy 67	17.IV.1972, 10.VII.1972
T	Racine	Tichigan Ck, T4N, R19E, S15 at Ranke Road crossing	13.VI.1972, 10.VII.1972, 2.VII.1972, 17.IX.1972, 29.X.1972, 8.XII.1972, 7.I.1973, 3.II.1973, 3.III.1973, 16.IV.1973

Voucher specimens from all localities have been collected and immediately preserved in FAA (10:7:2:1 95% ethanol:water:formalin:glacial acetic acid). Dried herbarium specimens (bearing numbers prefaced by WJW) and permanent microscope slides using KARO as a mountant (Woelkerling, 1970) as well as liquid preserved material have been retained in the author's personal collections, currently housed at WIS. Species determinations have been made primarily with the aid of the taxonomic key of Israelson (1942); the papers of Kylin (1912), Prescott (1951), Sirodot (1884), and Whitford and Schumacher (1969) also have been consulted.

RESULTS AND DISCUSSION

Two taxa of *Batrachospermum* found during this study have been identified to species. *Batrachospermum boryanum* Sirodot, not recorded previously from Wisconsin, occurred at seven localities (B, F, K, SC, SR, SS, T; abbreviations explained in Table 1), and with one exception (locality B), it always grew mixed with other *Batrachospermum* taxa. Sexually mature plants ranged in size from 4-21 cm with most plants averaging about 8-10 cm tall. Sexual plants have been encountered in all months except February, March, and October; further study will probably show that sexual plants do occur throughout the year.

Batrachospermum moniliforme Roth has been found at ten localities (BE, F, J, K, MC, N, SC, SR, SS, T), and has been reported previously from Wisconsin (Prescott, 1951). Except for two stations (J, N), it grew mixed with other *Batrachospermum* taxa. Sexually mature plants occurred throughout the year and ranged in length from 3-25 cm with an average height of 6-9 cm.

In addition to the above two taxa, sterile (and thus specifically unidentifiable) plants of *Batrachospermum* have been encountered at five localities (BE, M, Q, SC, T) from January-March, May-July, and in December. They varied in length from 3 cm to 15 cm. The size of some Wisconsin

plants (up to 25 cm) greatly exceeds the 6 cm maximum recorded by Rider and Wagner (1972) and the 10 cm maximum found by Israelson (1942).

All Wisconsin populations of *Batrachospermum* observed during this investigation grew at or near the headwaters of spring-fed streams, thus agreeing with the findings of Minckley and Tindall (1963). Rider and Wagner (1972) also recorded their taxa from a spring-fed stream but without mention of the headwater areas. Current velocities at Wisconsin localities never dipped below 10 cm/sec and in most cases exceeded 25 cm/sec. In addition, all Wisconsin localities but one (BE) contained rocky or rocky-sandy bottoms and usually appeared free from heavy siltation and high turbidity levels.

Except for seasonal fluctuations in temperature and diurnal fluctuations in carbon dioxide and oxygen levels, chemical and physical conditions at any one locality tended to remain within relatively narrow limits during the study period. Conditions did vary considerably between localities, however, and the taxa of *Batrachospermum* encountered appear to tolerate a fairly wide range of environmental conditions (Table 2).

Of particular note is the variation in carbon dioxide levels. At no time did CO_2 levels exceed 24 ppm, and levels as low as 1 ppm have been encountered. These values are decidedly lower than those reported by Minckley and Tindall (1963) for *Batrachospermum* sp. and by Rider and Wagner (1972) for *B. vagum*, but they more or less agree with the range in values measured by Rider and Wagner (op. cit.) for *B. moniliforme*. Since both species found in Wisconsin (*B. moniliforme* and *B. boryanum*) apparently require free CO_2 for photosynthesis (Ruttner, 1960), data from the present study strongly suggest that these taxa can survive at very low concentrations of free CO_2, at least for short periods of time.

At six of the thirteen localities (B, J, M, MC, N, Q), *Batrachospermum* plants were encountered on only one occasion (Table 1), and data for three additional localities

TABLE 2

RANGE IN ENVIRONMENTAL CONDITIONS UNDER WHICH *BATRACHOSPERMUM* OCCURRED

	B. boryanum	*B. moniliformis*	*B.* spp.
Alkalinity	15-342 ppm	12-387 ppm	287-368 ppm
Carbon Dioxide	2-23 ppm	1-23 ppm	2-20 ppm
Hardness, Calcium	2-340 ppm	15-410 ppm	176-408 ppm
Hardness, Total	22-442 ppm	29-500 ppm	352-420 ppm
Nitrate	1.0-4.8 ppm	0.2-16.5 ppm	2.0-10.0 ppm
Oxygen	8-20 ppm	5-21 ppm	5-17 ppm
pH	6.2-8.4	6.7-8.4	7.2-8.2
Ortho-phosphate	0.007-4.0 ppm	0.02-4.9 ppm	0.02-8.1 ppm
Temperature	6°-18°C	1°-21°C	4°-22°C
Turbidity	0-7 J.U.	0-10 J.U.	0-15 J.U.

TABLE 3

RANGE IN SELECTED ENVIRONMENTAL CONDITIONS AT SCUPPERNONG CK. (SC) AND TICHIGAN CK. (T) DURING STUDY PERIOD

Environmental Factor	SC	T
Alkalinity	275-310 ppm	300-360 ppm
Carbon Dioxide	2-23	3-18 ppm
Hardness, Ca	190-225 ppm	170-250 ppm
Hardness, Total	350-400 ppm	375-425 ppm
pH	7.5-8.4	7.7-8.3
Temperature	4-15°C	5-22°C

(BE, SR, SS) are confined to three or four dates. Consequently, information on seasonal changes is restricted to limited observations at four localities (F, K, SC, T) from either May or June, 1972 through April, 1973. *Batrachospermum boryanum* and *B. moniliforme* occurred in mixed populations at all four sites; consequently, reference to *Batrachospermum* in the ensuing discussion includes both taxa.

The Fontana population (F) grew in very hard water (Ca hardness $\leqq$ 250 ppm $CaCO_3$; total hardness 410 ppm $CaCO_3$), swift flowing stream 1-2 m across whose temtures ranged from 12°C in summer to 6°C in winter. Carbon dioxide levels varied from 2-23 ppm, pH from 7.8-8.4, and alkalinity from 330-390 ppm. The stream bottom was primary gravel. During most of the day the habitat was exposed to full sunlight.

When first discovered in June, 1972, *Batrachospermum* plants occurred in considerable numbers and reached lengths of up to 18 cm. By July, 1972, however, most of the plants had disappeared or were obviously moribund. Several plants (preserved as WJW 3936) appeared heavily calcified. The population disappeared entirely by August, and new adult gametophytes did not become apparent until December, 1972, when about a dozen plants up to 6 cm tall were discovered. By January, 1973, *Batrachospermum* had become the dominant alga in the stream with most plants averaging 3-6 cm in length. Throughout the remainder of the study period (ending in April, 1973), *Batrachospermum* maintained its dominance in the stream and plants gradually increased in size to 12-15 cm on the average.

Similar seasonal fluctuation in population levels also occurred at Koshwego Springs (K), where certain chemical and physical conditions differed considerably from those at Fontana. At Koshwego, the water was very soft (Ca hardness $\leqq$ 15 ppm $CaCO_3$; total hardness $\simeq$ 25-30 ppm $CaCO_3$), acid (pH varied from 6.2-7.0), and showed alkalinity readings of 12-34 ppm. Stream bottom varied from rocky to sandy to partially silty with *Batrachospermum*

confined to rocky areas. At all times, the habitat was subjected to deep shade. In other respects the two localities appear more or less similar; at Koshwego, temperature varied from 12°C in summer to 1.0°C in winter and CO_2 levels fluctuated between 1 and 11 ppm.

In May, 1972, *Batrachospermum* plants up to 8 cm tall dominated the stream vegetation, but by mid-July they had become very moribund or had disappeared. Small (i.e., less than 2.5 cm tall) plants reappeared in considerable numbers in November, 1972, and dominated the stream vegetation throughout the winter. Noticeable increase in size occurred between February (average size under 2.5 cm) and March, 1973 (average size 6 cm). Severe flooding and silting of the stream occurred in late March and early April, 1973, and the *Batrachospermum* population was almost entirely destroyed.

At the remaining two stations (SC, T) *Batrachospermum* plants occurred throughout the year and formed the dominant component of the algal vegetation during much of that time. Both stations had environments (Table 3) similar to that at Fontana except that one (SC) was largely shaded throughout the day and the other (T) was exposed to full sunlight during most of the day. In addition the latter (T) had summer temperatures of 18-22°C or 5-10°C higher than at the other hard water localities.

Immediately below the spring from which Scuppernong Creek originates, *Batrachospermum* plants constituted the dominant form of vegetation. Within 100 m, however, angiosperm vegetation became dominant and the *Batrachospermum* population consisted only of scattered plants. During winter months most plants encountered were 4-6 cm long and during summer they were 8-10 cm long; one 15 cm tall plant was encountered.

The Tichigan Creek population of *Batrachospermum* dominated the macroscopic vegetation throughout the year. Summer plants generally did not exceed 10 cm in length; winter plants all (i.e., December-April) were enormous in size and reached lengths of up to 25 cm. The very large

size of these individuals as compared to the other winter populations studied could not be accounted for on the basis of the physical or chemical parameters examined during the study.

The above observations suggest that different populations of *Batrachospermum* (at least in Wisconsin streams) may either produce mature gametophytes throughout the year (SC, T) or show seasonal variation with an absence of mature plants from mid-summer to late fall (F, K). They also suggest that maximum vegetative development can occur in spring (F, K), summer (SC), or winter (T). Previous American studies (Dillard, 1966, Minckley and Tindall, 1963, Rider and Wagner, 1972) all reported definite seasonal fluctuations in *Batrachospermum* populations with a disappearance of plants in summer and a reappearance in fall. Yoshida (1959), however, makes mention of both seasonal and year-round populations of *Batrachospermum* in Japanese streams.

Various attempts have been made to account for seasonal fluctuation in population levels in terms of temperature changes, changes in light intensity, and differences in current velocity (see Dillard, 1966, Minckley and Tindall, 1963, Rider and Wagner, 1972, Yoshida, 1959). The results of the Wisconsin study, however, indicate that mature plants and maximum vegetative development can occur under both low and high light intensities and under both summer and winter temperatures. Therefore, other factors, perhaps genetic, appear to be involved in determining why different populations of the same species either persist year round or show seasonal fluctuations. No relationship to current velocity has been observed in this investigation.

The apparently consistent occurrence of *Batrachospermum* in the headwater areas of spring-fed streams likewise requires further investigation. Minckley and Tindall (1963) suggest that the availability of unbound carbon dioxide may be a controlling factor (their stream reportedly has super-saturated CO_2 levels), but the relatively low CO_2 levels found during this study again suggest that other

factors may be involved, and additional study appears warranted.

SUMMARY

The occurrence and some ecological aspects of *Batrachospermum* in southeastern Wisconsin streams have been investigated. *Batrachospermum boryanum* (newly reported for Wisconsin), *B. moniliforme*, and *Batrachospermum* sp. occurred in 6.4% of the localities visited and were found in both alkaline, hard water and acid, soft water environments. Depending upon the population, mature plants persisted throughout the year or disappeared in summer and fall, and they showed maximum vegetative development in spring, or summer, or winter. The seasonal behavior does not appear to be correlated entirely with changes in light intensity or temperature. Likewise the apparent occurrence of *Batrachospermum* near the headwaters of spring-fed streams apparently cannot be explained solely on the basis of greater availability of unbound carbon dioxide in these habitats.

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A COUNTY CHECKLIST OF THE FERNS AND FERN ALLIES OF KANSAS, NEBRASKA, SOUTH DAKOTA, AND NORTH DAKOTA[1]

ALETA JO PETRIK-OTT

INTRODUCTION

To the present, there has been no comprehensive work dealing exclusively with the ferns and fern allies of what is considered to be the heart of the central plains and prairies of the United States, i.e., Kansas, Nebraska, South Dakota, and North Dakota.

Of the larger floras, Rydberg's "Flora of the Rocky Mountains and Adjacent Plains" (1917) extends eastward to longitude 102° W in Nebraska, South Dakota, and North Dakota. Rydberg's "Flora of the Prairies and Plains of Central North America" (1932) includes the ferns and fern allies of the aforementioned four states, but several taxa reported to be in these states have never been verified, many new taxa have been found since that time, and recent research has resulted in many nomenclatural changes. Fernald's account of the ferns and fern allies in "Gray's Manual of Botany" (1950) covers only the area in Nebraska and Kansas east of longitude 96° W and thus excludes the prairie and plains regions of the Dakotas, Nebraska, and Kansas.

Smaller, individual state floristic treatments briefly covering the ferns and/or fern allies are represented by Kellerman and Kellerman (1888), Saunders (1899), Bergman (1918), Petersen (1923), Over (1932), Gates (1940), Stevens (1950), and Winter, Winter, and Van Bruggen (1959). Floristic regional and state studies exclusively concerning ferns and/or fern allies are represented by Wilson (1885), Cragin (1885, 1886), Bessey (1892), Reed (1896), Fitzpatrick (1919, 1920a & b), Humfeld (1951a

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& b), McGregor and Hartman (1956), McGregor (1960), Brooks (1967, 1969), and Van Bruggen (1967).

Supporting specimens are not to be found for many records given in the existing literature, and many of the older records were based upon mis-identifications. The records given here are based entirely upon specimens from nine major herbaria in the region and my personal collections which are deposited in the University of Kansas herbarium. The nine herbaria are (abbreviations after Lanjouw and Stafleu, 1964):

KANU = The University of Kansas, Lawrence, Kansas
KSC = Kansas State University, Manhattan, Kansas
KSTC = Herbarium of the Kansas State Teachers College, Emporia, Kansas
MO = Missouri Botanical Garden, 2315 Tower Grove Avenue, Saint Louis 10, Missouri
NDA = North Dakota State University and Experiment Station, Fargo, North Dakota
NEB = University of Nebraska State Museum, Lincoln 8, Nebraska
SDC = Department of Botany, South Dakota State College, College Station, Brookings, South Dakota
SDU = University Herbarium, University of South Dakota, Vermillion, South Dakota
UMO = University of Missouri Herbarium, Columbia, Missouri

The following list was compiled during the years 1968-1970. Citations for each taxon are grouped alphabetically by state and county. Only one specimen for each county was chosen as representative. A map (Fig. 1) showing the counties in each state is included. To conserve space, it was considered sufficient to give only the collector's name and his collection number for each representative county specimen. In certain cases, a collection number was not given on the herbarium label; therefore, the date of the collection,

if indicated, was designated. It is realized that the county distributions of certain taxa have probably been extended since the termination of my study, but it has not come to my attention that any new taxa have been added.

Because there has been much confusion concerning the presence of certain taxa, which cannot be verified by existing specimens, a section on doubtful collections and excluded taxa has been appended to the checklist.

THE FERNS

Family Ophioglossaceae

Botrychium dissectum Spreng. var. **dissectum** Anleit. Kennt. Gewachse 3:172. 1804.

Kansas: CHEROKEE CO.: *R. L. McGregor* 3870 (KANU).

Botrychium dissectum Spreng. var. **obliquum** (Muhl.) Clute, Fern Bull. 10:76. 1902.

Kansas: ANDERSON CO.: *L. K. Magrath* 4988 (KANU). BOURBON CO.: *S. Stephens* 19492 (KANU). CHEROKEE CO.: *R. L. McGregor* 3860a (KANU). COFFEY CO.: *L. K. Magrath* 4979 (KANU). DOUGLAS CO.: *J. E. Bare* 762 (KANU). FRANKLIN CO.: *L. K. Magrath* 5086 and *A. Organ* (KANU). JEFFERSON CO.: *R. L. McGregor* 4154 (KANU). LINN CO.: *L. K. Magrath* 4938 (KANU). MIAMI CO.: *W. H. Horr* and *R. L. McGregor* 3617 (KANU). WYANDOTTE CO.: *L. K. Magrath* 5056 (KANU).

Botrychium lunaria (L.) Swartz, Schrad. Journ. Bot. 1800 (2):110. 1801.

North Dakota: MCHENRY CO.: *O. A. Stevens* 1530 (NDA).

Botrychium multifidum (S. G. Gmel.) Rupr. Beitr. Pflanzenk. Russ. Reich. 11:40. 1859.

Nebraska: FRANKLIN CO.: *E. M. Hussong* 4689 (NEB).
South Dakota: CUSTER CO.: *S. Stephens* 35426 and *R. Brooks* (KANU). PENNINGTON CO.: *T. Van Bruggen* 5042 (SDU).

Botrychium simplex E. Hitchc. Amer. Journ. Sci. 6:103. pl. 8. 1823.

South Dakota: LAWRENCE CO.: *C. A. Taylor* 7963 (SDC).

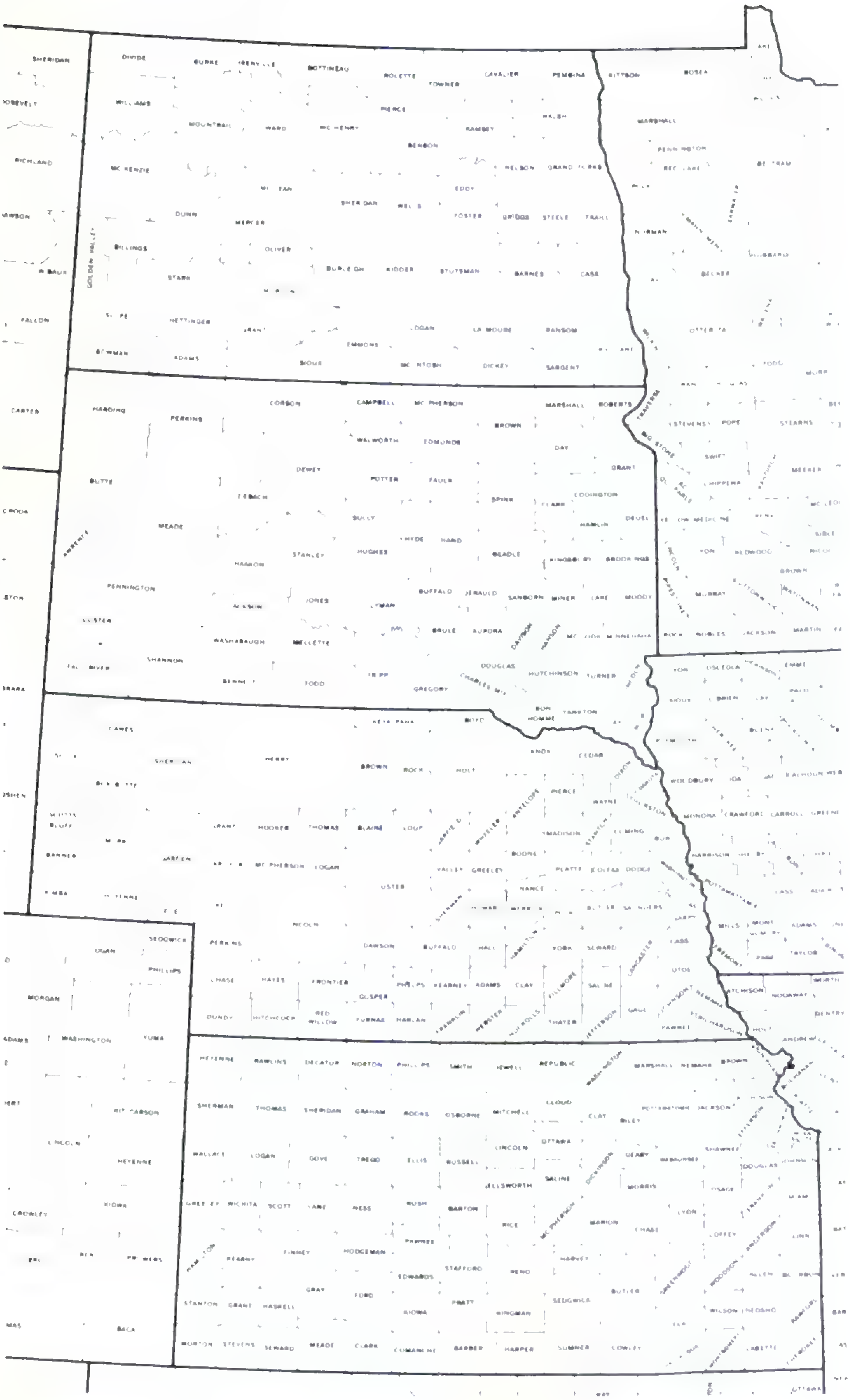

Figure 1. County map of Kansas, Nebraska, South Dakota, and North Dakota.

Botrychium virginianum (L.) Swartz, Schrad. Journ. Bot. 1800(2):111. 1801.

Kansas: ANDERSON CO.: *R. L. McGregor* 3211 (KANU). ATCHISON CO.: *A. J. Petrik-Ott* 752 (KANU). BOURBON CO.: *A. J. Petrik-Ott* 756 (KANU). BROWN CO.: *R. L. McGregor* 2836 (KANU). CHASE CO.: *B. B. Smyth*, 19 Aug., 1902 (KSC). CHAUTAUQUA CO.: *P. H. Humfeld* 842 (KANU). CHEROKEE CO.: *A. J. Petrik-Ott* 724 (KANU). COFFEY CO.: *L. K. Magrath* 3876 (KSTC). COWLEY CO.: *W. H. Horr* and *R. L. McGregor*, 23 July 1947 (KANU). CRAWFORD CO.: *A. J. Petrik-Ott* 725 (KANU). DONIPHAN CO.: *R. L. McGregor* 12258 (KANU). DOUGLAS CO.: *R. L. McGregor* 14217 (KANU). FRANKLIN CO.: *R. L. McGregor* 5592 (KANU). GEARY CO.: *A. S. Hitchcock*, June 1896 (KSC). GREENWOOD CO.: *S. Stephens* 2914 (KANU). JACKSON CO.: *R. L. McGregor* 2853 (KANU). JEFFERSON CO.: *R. L. McGregor* 880 (KANU). JOHNSON CO.: *P. H. Humfeld* 595 (KANU). LEAVENWORTH CO.: *P. H. Humfeld* 195 (KANU). LINN CO.: *A. J. Petrik-Ott* 763 (KANU). LYON CO.: *J. S. Wilson* 2042 (KSTC). MARSHALL CO.: *S. Stephens* 3291 (KANU). MIAMI CO.: *S. Stephens* 2312 (KANU). MONTGOMERY CO.: *R. L. McGregor* 12824 (KANU). NEMAHA CO.: *L. K. Magrath* 4506 (KANU). OSAGE CO.: *S. Stephens* 30602 (KANU). POTTAWATOMIE CO.: *S. Stephens* 4710 (KANU). RILEY CO.: *Miss Thackrey*, 24 May 1892 (KSC). SALINE CO.: *J. Hancin* 375 (KSC). SHAWNEE CO.: *L. D. Volle* 715 (KANU). WABAUNSEE CO.: *S. Stephens* 4798 (KANU). WILSON CO.: *L. C. Hulbert* 3686 (KSC). WOODSON CO.: *R. L. McGregor* 905 (KANU). WYANDOTTE CO.: *A. J. Petrik-Ott* 747 (KANU).

Nebraska: BURT CO.: *S. Stephens* 32072 and *R. Brooks* (KANU). CASS CO.: *A. J. Petrik-Ott* 776 (KANU). CHERRY CO.: *J. M. Bates* 6043 (NEB). DAKOTA CO.: *S. Stephen* 32048 and *R. Brooks* (KANU). DAWES CO.: *H. J. Webber* 6103 (NEB). DOUGLAS CO.: *W. Cleburne*, 9 July 1897 (NEB). GAGE CO.: *H. L. Shantz*, June 1904 (NEB). HALL CO.: *J. M. Bates* 3807 (NEB). HOLT CO.: *R. Brooks* 374 and *S. Stephens* (KANU). LANCASTER CO.: *H. J. Webber* 6102 (NEB). NEMAHA CO.: *S. Stephens* 3660 (KANU). OTOE CO.: *H. J. Webber*, 1 June 1889 (MO). RICHARDSON CO.: *A. J. Petrik-Ott* 773 (KANU). SARPY CO.: *W. Cleburne*, 3 June 1887 (NEB). SIOUX CO.: *A. F. Woods* 444 (NEB). THOMAS CO.: *P. A. Rydberg* 1467 (NEB). THURSTON CO.: *S. Stephens* 21066 (KANU).

North Dakota: BENSON CO.: *H. F. Bergman* 1890 (NDA). BOTTINEAU CO.: *H. F. Bergman* 2550 (NDA). CASS CO.: *H. F. Bergman* 1637 (NDA). DUNN CO.: *O. A. Stevens* and *D. R. Moir*, 14 Sept. 1956 (NDA). PEMBINA CO.: *L. R. Waldron* 1649 (NDA). RANSOM CO.: *S. Stephens* 33426 and *R. Brooks* (KANU). RICHLAND CO.: *O. A. Stevens* 424 (NDA). STARK CO.: *Mrs. M. Meissner*, 20 Aug. 1939 (NDA).

South Dakota: CLAY CO.: *G. B. Smith*, 22 Sept. 1966 (SDU). HARDING CO.: *S. S. Visher* 7057 (SDU). LAWRENCE CO.: *S. Stephens* 7395 (KANU). LINCOLN CO.: *N. Winter*, Oct. 1954 (SDU). MARSHALL CO.: *T. Van Brugggen* 4448 (SDU). ROBERTS CO.: *R. Brooks* 443 (KANU).

Ophioglossum engelmanni Prantl, Ber. Deutsch. Bot. Ges. 1:351. 1883.

Kansas: ALLEN CO.: *L. K. Magrath* 4977 (KANU). ANDERSON CO.: *R. H. Thompson*, 19 June 1949 (KANU). ATCHISON CO.: *R. L. McGregor* 887 (KANU). BOURBON CO.: *S. Stephens* 3978 (KANU). CHAUTAUQUA CO.: *R. L. McGregor* 4186 (KANU). CHEROKEE CO.: *R. L. McGregor* 15328 (KANU). COFFEY CO.: *L. K. Magrath* 3836 (KSTC). COWLEY CO.: *Rudy G. Koch* 3468 (KSC). DOUGLAS CO.: *P. H. Humfeld* 1011 (KANU). ELK CO.: *S. Stephens* 10754 (KANU). JOHNSON CO.: *R. H. Thompson*, 22 April 1941 (KANU). LEAVENWORTH CO.: *R. L. McGregor* 886 (KANU). MIAMI CO.: *P. H. Humfeld* 219 (KANU). MONTGOMERY CO.: *P. H. Humfeld* 107 (KANU). NEOSHO CO.: *W. W. Holland* 2622 (KANU). WILSON CO.: *R. L. McGregor*, 30 June 1947 (KANU).

Ophioglossum vulgatum L. Sp. Pl. 2:1062. 1753.

Nebraska: CHERRY CO.: *J. M. Bates* 5679 (NEB).

Family Osmundaceae

Osmunda regalis L. var. **spectabilis** (Willd.) A. Gray, Man. ed. 2:600. 1856.

Kansas: WILSON CO.: *L. L. Kiefer*, 5 Oct. 1961 (KANU). WOODSON CO.: *W. H. Horr*, 10 July 1930 (KANU).

Nebraska: *E. M. Hussong* 6776 (NEB).

Family Adiantaceae

Adiantum capillus-veneris L. Sp. Pl. 2:1096. 1753.

South Dakota: FALL RIVER CO.: *A. J. Petrik-Ott* 784 (KANU).

Adiantum pedatum L. Sp. Pl. 2:1095. 1753.

Kansas: ALLEN CO.: *R. L. McGregor* 968 (KANU). ATCHISON CO.: *R. L. McGregor* 2814 (KANU). BOURBON CO.: *R. L. McGregor* 979 (KANU). BROWN CO.: *R. L. McGregor* 904 (KANU). CHEROKEE CO.: *R. L. McGregor* 983 (KANU). COFFEY CO.: *R. L. McGregor* 918 (KANU). CRAWFORD CO.: *R. L. McGroger* 981 (KANU). DONIPHAN CO.: *A. J. Petrik-Ott* 753 (KANU). DOUGLAS CO.: *R. L. McGregor* 17356 (KANU). FRANKLIN CO.: *R. L. McGregor* 10043 (KANU). JACKSON CO.: *M. Reed*, 1 Sept. 1889 (KSC). JEFFERSON CO.: *R. L.*

McGregor 885 (KANU). JOHNSON CO.: *P. H. Humfeld* 611 (KANU). LEAVENWORTH CO.: *R. L. McGregor* 2792 (KANU). LINN CO.: *A. J. Petrik-Ott* 762 (KANU). MIAMI CO.: *R. L. McGregor* 896 (KANU). NEOSHO CO.: *M. D. Ewing*, Summer 1891 (KSC). OSAGE CO.: *R. L. McGregor* 891 (KANU). SHAWNEE CO.: *L. D. Volle* 131 (KANU). WILSON CO.: *H. Danell*, June 1890 (KSC). WOODSON CO.: *R. L. McGregor* 917 (KANU). WYANDOTTE CO.: *S. Stephens* 10863 (KANU).

Nebraska: CASS CO.: *S. Stephens* 3743 (KANU). CUMING CO.: *L. Bruner*, July 1880 (NEB). DOUGLAS CO.: *W. Cleburne*, June 1873 (NEB). LANCASTER CO.: *H. J. Webber* 6128 (NEB). NEMAHA CO.: *J. M. Bates* 5145 (NEB). OTOE CO.: *K. L. Johnson* 1584 and *D. E. Dallas* (KANU). PAWNEE CO.: *J. E. Shue*, May 1896 (NEB). RICHARDSON CO.: *A. J. Petrik-Ott* 770 (KANU). ROCK CO.: *J. M. Bates*, 13 Aug. 1900 (NEB). SARPY CO.: *W. L. Tolstead* and *H. C. Reynolds*, 17 May 1942 (NEB).

Cheilanthes alabamensis (Buckley) Kunze, Linnaea **20**:4. 1847.

Kansas: CHEROKEE CO.: *R. L. McGregor* 3865 (KANU).

Cheilanthes feei Moore, Index Fil. 38. 1857.

Kansas: BARBER CO.: *R. L. McGregor* 14950 (KANU). CHAUTAUQUA CO.: *A. J. Petrik-Ott* 745 (KANU). ELLSWORTH CO.: *R. L. McGregor* 1312 (KANU). FORD CO.: *R. L. McGregor* 10928 (KANU). HODGEMAN CO.: *R. L. McGregor* 10935 (KANU). LINCOLN CO.: *D. E. Lantz*, 3 May 1898 (KSC). OTTAWA CO.: *A. J. Petrik-Ott* 769 (KANU). RUSSELL CO.: *L. C. Hulbert* 4346 (KSC). STANTON CO.: *R. L. McGregor* 16115 (KANU).

Nebraska: BANNER CO.: *P. A. Rydberg* 479 (NEB). SCOTTS BLUFF CO.: *S. Stephens* 5481 (KANU).

South Dakota: CUSTER CO.: *S. Stephens* 6167 (KANU). FALL RIVER CO.: *S. Stephens* 5797 (KANU). HARDING CO.: *S. Stephens* and *R. Brooks* 425 (KANU). LAWRENCE CO.: *S. Stephens* 7475 (KANU). MEADE CO.: *E. J. Palmer* 37017 (MO). PENNINGTON CO.: *S. Stephens* 7134 (KANU).

Cheilanthes lanosa (Michx.) D. C. Eat. in Torr. Rep. U. S. and Mex. Bound. Surv. 2:234. 1859.

Kansas: CHAUTAUQUA CO.: *A. J. Petrik-Ott* 745 (KANU). CHEROKEE CO.: *R. L. McGregor* 11063 (KANU). ELK CO.: R. L. McGregor 926 (KANU). MONTGOMERY CO.: *R. L. McGregor* 946 (KANU). WILSON CO.: *R. L. McGregor* 925 (KANU). WOODSON CO.: *R. L. McGregor* 914 (KANU).

Cheilanthes tomentosa Link, Hort. Berol. 2:42. 1833.

Kansas: CHEROKEE CO.: *R. L. McGregor* 3866 (KANU).

Notholaena dealbata (Pursh) Kunze, Amer. Journ. Sci. II. 6:82. 1848.

Kansas: ALLEN CO.: *R. L. McGregor* 3335 (KANU). ANDERSON CO.: *R. L. McGregor* 3209 (KANU). BOURBON CO.: *A. J. Petrik-Ott* 759 (KANU). CHAUTAUQUA CO.: *R. L. McGregor* 951 (KANU). CHEROKEE CO.: *R. L. McGregor* 971 (KANU). COFFEY CO.: *R. L. McGregor* 910 (KANU). COWLEY CO.: *R. G. Koch* 1764 (KANU). CRAWFORD CO.: *R. L. McGregor* 973 (KANU). DOUGLAS CO.: *R. L. McGregor* 874 (KANU). ELK CO.: *R. L. McGregor* 15880 (KANU). FRANKLIN CO.: *R. L. McGregor* 3309 (KANU). GEARY CO.: *C. C. Parry*, April 1873 (MO). GREENWOOD CO.: *R. L. McGregor* 994 (KANU). JEFFERSON CO.: *P. H. Humfeld* 132 (KANU). JOHNSON CO.: *R. L. McGregor* 3435 (KANU). LABETTE CO.: *R. L. McGregor* 955 (KANU). LEAVENWORTH CO.: *P. H. Humfeld* 1019 (KANU). LINCOLN CO.: *D. E. Lantz*, 3 May 1898 (KSC). LINN CO.: *M. Campbell*, 28 June 1890 (KSC). MIAMI CO.: *P. H. Humfeld* 214 (KANU). MONTGOMERY CO.: *A. J. Petrik-Ott* 735 (KANU). MORRIS CO.: *C. C. Parry*, 29 April 1873 (MO). NEOSHO CO.: *R. L. McGregor* 957 (KANU). POTTAWATOMIE CO.: *P. H. Humfeld* 396 (KANU). RILEY CO.: *W. A. Kellerman* 19 Aug. 1887 (KSC). SHAWNEE CO.: *B. B. Smyth* 70 (KSC). WILSON CO.: *B. L. Wagenknecht* 2231 (KANU). WOODSON CO.: *R. L. McGregor* 992 (KANU). WYANDOTTE CO.: *S. Stephens* 10858 (KANU).

Nebraska: CASS CO.: *T. A. Williams* 6773 (NEB).

Pellaea atropurpurea (L.) Link, Fil. Sp. Hort. Reg. Bot. Berol. Cul. 59. 1841.

Kansas: ALLEN CO.: *R. L. McGregor* 3332 (KANU). ANDERSON CO.: *R. L. McGregor* 3209 (KANU). ATCHISON CO.: *R. L. McGregor* 2811 (KANU). BARBER CO.: *E. L. Richards* 3716 (KANU). BARTON CO.: *S. Stephens* 8380 (KANU). BOURBON CO.: *A. J. Petrik-Ott* 757 (KANU). CHAUTAUQUA CO.: *P. H. Humfeld* 855 (KANU). CHEROKEE CO.: *E. L. Richards* 3104 (KANU). CLAY CO.: *R. L. McGregor* 5016 (KANU). CLOUD CO.: *S. V. Fraser* 558 (KSC). COFFEY CO.: *R. L. McGregor* 913 (KANU). COMANCHE CO.: *R. L. McGregor* 10944 (KANU). COWLEY CO.: *S. Stephens* 3020 (KANU). CRAWFORD CO.: *C. L. Merritt*, Summer 1941 (KSC). DONIPHAN CO.: *F. Agrelius*, Aug. 1913 (KSTC). DOUGLAS CO.: R. L. McGregor 640 (KANU). ELK CO.: *R. L. McGregor* 15877 (KANU). ELLSWORTH CO.: *R. L. McGregor* 17326 (KANU). FRANKLIN CO.: *R. L. McGregor* 889 (KANU). GREENWOOD CO.: *S. Stephens* 9907 (KANU). JEFFERSON CO.: *P. H. Humfeld* 133 (KANU). JOHNSON CO.: *R. L. McGregor* 3871 (KANU). KIOWA CO.: *A. S. Hitchcock*, Aug. 1896 (KSC). LEAVENWORTH CO.: *R. L. McGregor* 2866 (KANU). LINCOLN CO.: *P. H. Humfeld* 965 (KANU). LYON CO.: *F. Agrelius*, 10 April 1946 (KSTC). MARSHALL CO.: *S. Stephens* 4666 (KANU). MCPHERSON CO.: *R. L. McGregor* 13720 (KANU). MIAMI

CO.: *P. H. Humfeld* 160 (KANU). MONTGOMERY CO.: *A. J. Petrik-Ott* 736 (KANU). NEOSHO CO.: *W. W. Holland* 872 (KANU). OSAGE CO.: *R. L. McGregor* 3318 (KANU). OTTAWA CO.: *A. J. Petrik-Ott* 768 (KANU). RICE CO.: *R. L. McGregor* 2706 (KANU). RILEY CO.: *D. J. Cashen,* 24 Oct. 1920 (KSC). RUSSELL CO.: *R. L. McGregor* 12676 (KANU). SALINE CO.: *R. L. McGregor* 2689 (KANU). SHAWNEE CO.: *P. H. Humfeld* 145 (KANU). WABAUNSEE CO.: *B. B. Smyth,* 8 Aug. 1890 (UMO). WILSON CO.: *B. L. Wagenknecht* 2217 (KANU). WOODSON CO.: *R. L. McGregor* 915 (KANU). WYANDOTTE CO.: *S. Stephens* 10860 (KANU).

Nebraska: BOX BUTTE CO.: *M. P. Somer,* Aug. 1909 (NEB). CASS CO.: *H. J. Webber,* 23 May 1887 (NEB). JEFFERSON CO.: *A. F. Woods* and *D. Saunders* 2001 (NEB). NEMAHA CO.: *J. M. Bates* 6683 (NEB).

South Dakota: CUSTER CO.: *S. Stephens* 6158 (KANU). FALL RIVER CO.: *S. Stephens* 5796 (KANU). LAWRENCE CO.: *C. A. Taylor* 7464 (SDC). MEADE CO.: *E. J. Palmer* 37019 (MO). PENNINGTON CO.: *S. Stephens* 7133 (KANU).

Pellaea glabella Mett. ex Kuhn, Linnaea **36**:87. 1869.

Kansas: ALLEN CO.: *R. L. McGregor* 3331 (KANU). BOURBON CO.: *R. L. McGregor* 3340 (KANU). CHASE CO.: *F. Agrelius,* 9 Aug. 1953 (KSTC). CHAUTAUQUA CO.: *P. H. Humfeld* 846 (KANU). COWLEY CO.: *S. Stephens* 3020 (KANU). DOUGLAS CO.: *R. L. McGregor* 649 (KANU). FRANKLIN CO.: *R. L. McGregor* 892 (KANU). GEARY CO.: *P. H. Humfeld* 967 (KANU). GREENWOOD CO.: *P. H. Humfeld* 799 (KANU). JOHNSON CO.: *R. L. McGregor* 3433 (KANU). LABETTE CO.: *P. M. Maus,* 26 May 1927 (KSC). LEAVENWORTH CO.: *P. H. Humfeld* 187 (KANU). LINCOLN CO.: *D. E. Lantz,* 3 May 1898 (KSC). LINN CO.: *P. H. Humfeld* 40 (KANU). LYON CO.: *F. Agrelius,* 10 May 1945 (KSTC). MARSHALL CO.: *W. H. Horr* 4616 (KANU). MONTGOMERY CO.: *R. L. McGregor* 10839 (KANU). OTTAWA CO.: *A. J. Petrik-Ott* 767 (KANU). POTTAWATOMIE CO.: *P. H. Humfeld* 395 (KANU). RILEY CO.: *W. A. Kellerman,* 28 May 1887 (KSC). SCOTT CO.: *F. Agrelius,* 16 Aug. 1912 (KSTC). WABAUNSEE CO.: *R. L. McGregor* 12371 (KANU). WILSON CO.: *P. H. Humfeld* 120 (KANU). WOODSON CO.: *W. H. Horr,* 10 July 1930 (KANU).

North Dakota: BOWMAN CO.: *O. A. Stevens* and *D. R. Moir* 2304 (NDA). DUNN CO.: *O. A. Stevens,* 8 June 1938 (NDA). GOLDEN VALLEY CO.: *S. Stephens* 23465 and *R. Brooks* (KANU). GRANT CO.: *W. B. Bell* 1395 (NDA). HETTINGER CO.: *Mrs. M. Meissner,* 10 Aug. 1938 (NDA). MCKENZIE CO.: *O. A. Stevens* and *D. R. Moir,* 14 Sept. 1956 (NDA). MORTON CO.: *O. A. Stevens,* 17 June 1945 (NDA). OLIVER CO.: *O. A. Stevens,* 7 Aug. 1938 (NDA).

South Dakota: CLAY CO.: *W. H. Over* 1680 (SDU). CUSTER CO.: *P. A. Rydberg* 1191 (NEB). HARDING CO.: *Over* and *Solem* 12758 (SDU). LAWRENCE CO.: *S. Stephens* 7518 (KANU). PENNINGTON CO.: *S. Stephens* 7350 (KANU).

Family Aspidiaceae

Athyrium filix-femina (L.) Roth, Tent. Fl. Germ. 3:65. 1799.

Nebraska: ADAMS CO.: *J. M. Bates*, 12 July 1913 (NEB). BOYD CO.: *J. M. Bates* 1094 (NEB). BROWN CO.: *F. Clements* 2938 (NEB).

North Dakota: CAVALIER CO.: *O. A. Stevens* 2504 (NDA). PEMBINA CO.: *R. Brooks* 449 (KANU). RICHLAND CO.: *O. A. Stevens* 149 (NDA).

South Dakota: CUSTER CO.: *A. J. Petrik-Ott* 792 (KANU). LAWRENCE CO.: *E. J. Palmer* 37532 (MO). MINNEHAHA CO.: *C. A. Taylor* 7651 (SDC). PENNINGTON CO.: *S. Stephens* 7175 (KANU).

Athyrium pycnocarpon (Spreng.) Tidestr. Elys. Marianum 1:36. 1906.

Kansas: LEAVENWORTH CO.: *J. Wilson* 3729 (KANU). WYANDOTTE CO.: *K. K. Mackenzie* 307 (KSC).

Cystopteris bulbifera (L.) Bernh. Schrad. Neu. Journ. Bot. 1(2):10. 1806.

South Dakota: ROBERTS CO.: *A. J. Petrik-Ott* 800 (KANU).

Cystopteris fragilis (L.) Bernh. Schrad. Neu. Journ. Bot. 1(2):26. pl. 2. fig. 9. 1806.

Kansas: CRAWFORD CO.: *W. W. Holland* 963 (KANU). ELLSWORTH CO.: *R. L. McGregor* 17324 (KANU). JOHNSON CO.: *M. A. Carleton*, 25 Aug. 1892 (KSC). MONTGOMERY CO.: *F. Agrelius*, 28 May 1930 (KSTC). RICE CO.: *R. L. McGregor* 2704 (KANU). RILEY CO.: *H. F. Bergman*, 9 Sept. 1910 (NDA). SALINE CO.: *R. L. McGregor* 2688 (KANU). WILSON CO.: *H. Willis* 16 (KSTC). WOODSON CO.: *R. Brooks* 973 (KSTC).

Nebraska: ANTELOPE CO.: *N. F. Petersen* 1908 (NEB). BROWN CO.: *C. E. Bessey*, 23 July 1887 (NEB). CASS CO.: *S. Stephens* 18922 (KANU). CHERRY CO.: *W. L. Tolstead*, 25 June 1937 (NEB). CUMING CO.: *L. Bruner*, July 1880 (NEB). CUSTER CO.: *H. J. Webber* 6121 (NEB). DAKOTA CO.: *S. Stephens* 21144 (KANU). DAWES CO.: *S. Stephens* 24606 and *R. Brooks* (KANU). DIXON CO.: *F. Clements* 2556 (NEB). DOUGLAS CO.: *W. Cleburne*, 28 June 1873 (NEB). HOLT CO.: *J. M. Bates*, 21 Aug. 1895 (NEB). JOHNSON CO.: *No collector given*, 189? (NEB). KEYA PAHA CO.: *W. Kiener* 23692 (MO). KNOX CO.: *W. T. Barker* 2652 (KANU). LANCASTER CO.: *T. Walton*, 20 May 1886 (NEB). RICHARDSON CO.: *J. M. Winter*, July 1931 (SDU). SAUNDERS CO.: *T. A. Williams*, 24 June 1890 (NEB). SEWARD CO.: *H. J. Webber* 6116 (NEB). SIOUX CO.: *A. J. Petrik-Ott* 783 (KANU). THOMAS CO.: *P. A. Rydberg* 1479 (NEB). WEBSTER CO.: *J. M. Bates*, 17 April 1905 (NEB).

North Dakota: BARNES CO.: *H. F. Bergman* 2292 (NDA). BENSON CO.: *R. Brooks* 456 (KANU). BILLINGS CO.: *R. Brooks* 419 (KANU). DUNN CO.: *R. Brooks* 395 (KANU). GOLDEN VALLEY CO.: *S. Stephens* 23453 and *R. Brooks* (KANU). GRANT CO.: *O. A. Stevens*, 10 July 1964 (NDA). MCKENZIE CO.: *R. L. McGregor* and *J. E. Bare* 1153 (KANU). MCLEAN CO.: *R. Brooks* 398 (KANU). MERCER CO.: *R. Brooks* 391 (KANU). MORTON CO.: *R. Brooks* 389 (KANU). PIERCE CO.: *O. A. Stevens*, 16 July 1939 (NDA). RANSOM CO.: *S. Stephens* 33423 and *R. Brooks* (KANU). SIOUX CO.: *A. J. Petrik-Ott* 797 (KANU). STARK CO.: *C. H. Waldron*, 23 June 1912 (NDA). STUTSMAN CO.: *C. C. Schmidt*, 5 July 1897 (NDA). WARD CO.: *R. Brooks* 400 (KANU). WILLIAMS CO.: *O. A. Stevens*, 8 Aug. 1915 (NDA).

South Dakota: BRULE CO.: *R. Brooks* 461 (KANU). CLAY CO.: *W. H. Over* 11128 (SDU). CUSTER CO.: *A. J. Petrik-Ott* 789 (KANU). DEWEY CO.: *S. Stephens* 33798 and *R. Brooks* (KANU). FALL RIVER CO.: *S. Stephens* 5795 (KANU). GRANT CO.: *W. H. Over* 7033 (SDU). GREGORY CO.: *S. Stephens* and *R. Brooks* 375 (KANU). HAAKON CO.: *S. Stephens* and *R. Brooks* 379 (KANU). HARDING CO.: *S. Stephens* 7922 (KANU). LAWRENCE CO.: *A. J. Petrik-Ott* 795 (KANU). MARSHALL CO.: *O. A. Stevens* and *D. R. Moir*, 30 May 1957 (NDA). MEADE CO.: *E. J. Palmer* 37069 (KANU). MINNEHAHA CO.: *L. J. Harms* 2689 (KANU). PENNINGTON CO.: *S. Stephens* 7304 (KANU). ROBERTS CO.: *S. Stephens* 21471 (KANU). STANLEY CO.: *S. Stephens* and *R. Brooks* 377 (KANU). TODD CO.: *L. Stanley*, 24 May 1966 (STU). UNION CO.: *T. Van Bruggen* 4917 (SDU). WASHABAUGH CO.: *J. E. Bare* 1227 (KANU). ZIEBACH CO.: *R. Brooks* 380 and *S. Stephens* (KANU).

Cystopteris protrusa (Weath.) Blasdell, Mem. Torrey Bot. Club 21(4):41, 42. *pl. 3*. 1963.

Kansas: ANDERSON CO.: *R. L. McGregor* 3458 (KANU). ATCHISON CO.: *R. L. McGregor* 2817 (KANU). BROWN CO.: *R. L. McGregor* 2937 (KANU). CHAUTAUQUA CO.: *P. H. Humfeld* 868 (KANU). CHEROKEE CO.: *S. Stephens* 4136 (KANU). DONIPHAN CO.: *A. J. Petrik-Ott* 755 (KANU). DOUGLAS CO.: *P. H. Humfeld* 383 (KANU). ELK CO.: *S. Stephens* 10768 (KANU). FRANKLIN CO.: *R. L. McGregor* 10041 (KANU). GREENWOOD CO.: *R. L. McGregor* 3419 (KANU). JEFFERSON CO.: *P. H. Humfeld* 201 (KANU). JOHNSON CO.: *R. L. McGregor* 3431 (KANU). LEAVENWORTH CO.: *A. J. Petrik-Ott* 750 (KANU). LINN CO.: *R. L. McGregor* 3465 (KANU). MIAMI CO.: *R. L. McGregor* 2788 (KANU). MONTGOMERY CO.: *L. C. Hulbert* 3678 (KANU). NEOSHO CO.: *W. W. Holland* 943 (KANU). OSAGE CO.: *R. L. McGregor* 3316 (KANU). SHAWNEE CO.: *A. J. Petrik-Ott* 726 (KANU). WYANDOTTE CO.: *A. J. Petrik-Ott* 748 (KANU).

Nebraska: ADAMS CO.: *J. M. Bates*, 12 July 1913 (NEB). CASS CO.: *A. J. Petrik-Ott* 777 (KANU). DOUGLAS CO.: *H. J. Webber* 6118 (NEB). LANCASTER CO.: *E. B. Robinson*, May 1895 (NEB). NEMAHA CO.: *S. Stephens* 3626 (KANU). OTOE CO.: *H. J. Webber* 6115 (NEB). RICHARDSON CO.: *A. J. Petrik-Ott* 775 (KANU). SARPY CO.: *W. Cleburne*, 22 May 1888 (NEB). THURSTON CO.: *S. Stephens* 21067 (KANU).

Cystopteris × tennesseensis Shaver, Journ. Tennessee Acad. Sci. **25**(2):107. 1950.

Kansas: ALLEN CO.: *S. Stephens* 10688 (KANU). ANDERSON CO.: *R. L. McGregor* 3457 (KANU). BOURBON CO.: *A. J. Petrik-Ott* 761 (KANU). CHASE CO.: *F. Agrelius*, 9 Aug. 1953 (KSTC). CHAUTAUQUA CO.: *A. J. Petrik-Ott* 744 (KANU). CHEROKEE CO.: *E. J. Palmer* 20889 (KANU). CLAY CO.: *I. Avery*, 29 Sept. 1895 (KSC). COFFEY CO.: *J. E. Taylor, B. L. Taylor* and *L. K. Magrath* 3820 (KANU). COWLEY CO.: *W. H. Horr* 3152 (KANU). DOUGLAS CO.: *A. J. Petrik-Ott* 727 (KANU). ELLSWORTH CO.: *R. L. McGregor* 2696 (KANU). FRANKLIN CO.: *R. L. McGregor* 3095 (KANU). GREENWOOD CO.: *R. L. McGregor* 17216 (KANU). JEFFERSON CO.: *R. L. McGregor* 3452 (KANU). JOHNSON CO.: *R. L. McGregor* 3876 (KANU). LEAVENWORTH CO.: *S. Stephens* 19444 (KANU). LINN CO.: *A. J. Petrik-Ott* 766 (KANU). MARSHALL CO.: *S. Stephens* 4665 (KANU). MIAMI CO.: *P. H. Humfeld* 212 (KANU). MONTGOMERY CO.: *A. J. Petrik-Ott* 734 (KANU). NEOSHO CO.: *S. Stephens* 18763 (KANU). OSAGE CO.: *R. L. McGregor* 3320 (KANU). RILEY CO.: *J. B. S. Norton*, 25 Aug. 1892 (MO). RUSSELL CO.: *W. H. Horr* 3266 (KANU). SHAWNEE CO.: *B. B. Smyth*, May 1897 (KSC). WABAUNSEE CO.: *R. L. McGregor* 12372 (KANU). WILSON CO.: *R. L. McGregor* 3404 (KANU). WOODSON CO.: *A. J. Petrik-Ott* 729 (KANU). WYANDOTTE CO.: *R. L. McGregor* 2418 (KANU).

Dryopteris carthusiana (Vill.) H. P. Fuchs, Bull. Soc. France **105**:339. 1958.

Nebraska: BROWN CO.: *F. Clements* 2939 (NEB). CASS CO.: *E. Stoner*, 14 May 1892 (NEB). CHERRY CO.: *W. L. Tolstead* 653 (NEB). LANCASTER CO.: *H. J. Webber* 6122 (NEB). THOMAS CO.: *P. A. Rydberg* 1484 (NEB).

North Dakota: CASS CO.: *C. Waldron*, 5 July 1909 (NDA). PEMBINA CO.: *R. Brooks* 457 (KANU). RANSOM CO.: *R. A. Shunk*, Aug. 1916 (NDA). RICHLAND CO.: *O. A. Stevens* 1313 (NDA).

Dryopteris cristata (L.) A. Gray, Man. ed. 1. 631. 1848.

Nebraska: HOOKER CO.: *No collector given*, 12 July 1893 (SDC). THOMAS CO.: *P. A. Rydberg* 1530 (NEB).

North Dakota: PEMBINA CO.: *R. Brooks* 453 (KANU). RANSOM CO.: *R. A. Shunk*, Aug. 1916 (NDA).

Dryopteris filix-mas (L.) Schott, Gen. Fil. t. 9. 1834.

South Dakota: CUSTER CO.: *S. Stephens* 5896 (KANU). HARDING CO.: *S. S. Visher* 7067 (SDU). LAWRENCE CO.: *A. J. Petrik-Ott* 794 (KANU). MEADE CO.: *P. A. Rydberg* 1197 (SDC). PENNINGTON CO.: *C. A. Taylor* 8072 (SDC).

Dryopteris marginalis (L.) A. Gray, Man. ed. 1. 632. 1848.

Kansas: ANDERSON CO.: *E. Hartman* 585 (KSTC). CHAUTAUQUA CO.: *A. J. Petrik-Ott* 740 (KANU). CHEROKEE CO.: *R. L. McGregor* 984 (KANU). COFFEY CO.: *R. L. McGregor* 908 (KANU). ELK CO.: *R. L. McGregor* 927 (KANU). GREENWOOD CO.: *R. Brooks* 469 and *S. Stephens* (KANU). LEAVENWORTH CO.: *R. L. McGregor* 2791 (KANU). MONTGOMERY CO.: *R. L. McGregor* 3394 (KANU). SALINE CO.: *J. Hancin* 1718 (KSC). WILSON CO.: *B. L. Wagenknecht* 2252 (KANU). WOODSON CO.: *A. J. Petrik-Ott* 733 (KANU).

Gymnocarpium dryopteris (L.) Newm. Phytologist 4: app. XXIV. 1851.

South Dakota: CUSTER CO.: *S. Stephens* 5995 (KANU). LAWRENCE CO.: *E. J. Palmer* 37537 (UMO).

Phegopteris hexagonoptera (Michx.) Fee, Gen. Fil. 243. 1850-52.

Kansas: CHEROKEE CO.: *R. L. McGregor* 3843 (KANU).

Polystichum acrostichoides (Michx.) Schott, Gen. Fil. *pl. 9.* 1834.

Kansas: CHAUTAUQUA CO.: *A. J. Petrik-Ott* 741 (KANU). CHEROKEE CO.: *S. Stephens* 8589 (KANU). FRANKLIN CO.: *S. Stephens* 2890 (KANU). GREENWOOD CO.: *W. H. Horr*, 10 June 1939 (KANU). MONTGOMERY CO.: *R. L. McGregor* 949 (KANU). WILSON CO.: *R. L. McGregor* 922 (KANU). WOODSON CO.: *R. L. McGregor* 916 (KANU).

Polystichum munitum (Kaulf.) Presl, Tent. Pterid. 83. 1836.

South Dakota: PENNINGTON CO.: *S. Stephens* and *R. Brooks* 427 (KANU).

Thelypteris palustris Schott, Gen. Fil. t. 10. 1834.

Kansas: CHAUTAUQUA CO.: *R. L. McGregor* 2414 (KANU). DONIPHAN CO.: *G. L. Clothier* and *H. N. Whitford*, 31 July 1897 (KSC). DOUGLAS CO.: *R. L. McGregor* 15065 (KANU). ELK CO.: *R. L. McGregor* 928 (KANU). ELLSWORTH CO.: *O. A. Kolstad* 1963 (KANU). GREENWOOD CO.: *R. Brooks* 468 and *S. Stephens* (KANU). MONT-

GOMERY CO.: *R. L. McGregor* 3397 (KANU). POTTAWATOMIE CO.: *W. A. Kellerman*, 29 Sept. 1888 (KSC). RILEY CO.: *W. A. Kellerman*, 29 Sept. 1888 (MO). SALINE CO.: *J. Hancin* 1761 (KSC). WASHINGTON CO.: *T. C. Dodd, Jr.* 25 (KSC). WILSON CO.: *R. L. McGregor* 921 (KANU). WOODSON CO.: *R. L. McGregor* 906 (KANU).

Nebraska: BLAINE CO.: *R. Brooks* 792 (KSTC). BROWN CO.: *C. E. Bessey*, 23 July 1887 (NEB). BUFFALO CO.: *Misses Smith* and *Lee* 7704 (NEB). CHERRY CO.: *S. Stephens* 8201 (KANU). DODGE CO.: *C. E. Bessey*, 9 Aug. 1872 (NEB). DOUGLAS CO.: *W. Cleburne*, Aug. 1881 (NEB). FRANKLIN CO.: *E. M. Hussong* 6777 (NEB). HALL CO.: *R. J. Lemaire* 2239 (NEB). HOLT CO.: *J. M. Bates*, 31 July 1899 (NEB). JEFFERSON CO.: *A. F. Woods* and *D. Saunders* 2004 (NEB). KEARNEY CO.: *Dr. Hapeman*, July 1892 (NEB). LOUP CO.: *S. Stephens* 6852 (KANU). NEMAHA CO.: *J. M. Bates*, 5 July 1910 (NEB). SHERIDAN CO.: *F. Sandoz* 378 (NEB). THOMAS CO.: *H. J. Webber*, 12 July 1889 (KSC). WHEELER CO.: *R. L. McGregor* 19370 (KANU).

North Dakota: RANSOM CO.: *R. A. Shunk*, 15 Aug. 1916 (NDA).

South Dakota: BENNETT CO.: *W. H. Over* 15884 (SDU). PENNINGTON CO.: *S. S. Visher* 1614 (SDU). TODD CO.: *T. Van Bruggen* 5108 (SDU).

Woodsia obtusa (Spreng.) Torr. Geo. Rep. New York Nat. Hist. Sur. 4:195 Albany. 1840.

Kansas: ALLEN CO.: *P. H. Humfeld* 326 (KANU). ANDERSON CO.: *P. H. Humfeld* 291 (KANU). ATCHISON CO.: *H. W. Blocker* 809 (KSC). BARBER CO.: *R. L. McGregor* 14792 (KANU). BARTON CO.: *S. Stephens* 8379 (KANU). BOURBON CO.: *A. J. Petrik-Ott* 760 (KANU). CHAUTAUQUA CO.: *P. H. Humfeld* 866 (KANU). CHEROKEE CO.: *A. J. Petrik-Ott* 723 (KANU). CLAY CO.: *C. Weber* 318 (KSC). CLOUD CO.: *S. V. Fraser* 557 (KSC). COFFEY CO.: *G. L. Clothier* and *H. N. Whitford*, 31 Aug. 1897 (KSC). COWLEY CO.: *Palmer* 21256 (KANU). CRAWFORD CO.: *R. L. McGregor* 976 (KANU). DOUGLAS CO.: *R. L. McGregor* 15074 (KANU). ELK CO.: *S. Stephens* 10767 (KANU). ELLSWORTH CO.: *R. L. McGregor* 17325 (KANU). FRANKLIN CO.: *J. E. Bare* 257 (KANU). GREENWOOD CO.: *S. Stephens* 15841 and *R. Brooks* (KANU). JEFFERSON CO.: *R. L. McGregor* 883 (KANU). JOHNSON CO.: *R. L. McGregor* 897 (KANU). LABETTE CO.: *S. Stephens* 11044 (KANU). LEAVENWORTH CO.: *A. J. Petrik-Ott* 751 (KANU). LINCOLN CO.: *P. H. Humfeld* 423 (KANU). LINN CO.: *A. J. Petrik-Ott* 765 (KANU). LYON CO.: *F. Agrelius*, Sept. 1897 (KSTC). MARSHALL CO.: *S. Stephens* 4664 (KANU). MCPHERSON CO.: *P. H. Humfeld* 439 (KANU). MIAMI CO.: *P. H. Humfeld* 222 (KANU). MONTGOMERY CO.: *W. H. Horr* E466 (KANU). NEMAHA CO.: *R. L. McGregor* 903 (KANU). NEOSHO CO.: *S. Stephens* 18763 (KANU). OSAGE CO.: *R. L. McGregor* 888 (KANU). OTTAWA CO.: *S. Stephens* 10913 (KANU).

POTTAWATOMIE CO.: *P. H. Humfeld* 393 (KANU). RICE CO.: *E. L. Richards* 1625 (KANU). RILEY CO.: *P. H. Humfeld* 406 (KANU). RUSSELL CO.: *P. H. Humfeld* 954 (KANU). SALINE CO.: *P. H. Humfeld* 408 (KANU). SHAWNEE CO.: *L. D. Volle* 324A (KANU). STAFFORD CO.: *A. H. Curtiss*, 3 June 1905 (KSC). SUMNER CO.: *D. Birkholz* 2785 (KANU). WABAUNSEE CO.: *S. Stephens* 4826 (KANU). WASHINGTON CO.: *S. Stephens* 10893 (KANU). WILSON CO.: *R. L. McGregor* 962 (KANU). WOODSON CO.: *A. J. Petrik-Ott* 719 (KANU). WYANDOTTE CO.: *P. H. Humfeld* 193 (KANU).

Nebraska: DAKOTA CO.: *S. Stephens* 21145 (KANU). DOUGLAS CO.: *K. L. Johnson* 1606 and *D. E. Dallas* (KANU). GAGE CO.: *E. A. Fiala*, 7 Sept. 1925 (NEB). HOOKER CO.: *W. Kiener* 24000 (MO). JEFFERSON CO.: *A. F. Woods* and *D. Saunders* 2002 (NEB). LANCASTER CO.: *A. S. Hunter* 6774 (NEB). PAWNEE CO.: *C. H. Barnard*, 1892 (NEB). SAUNDERS CO.: *W. Cleburne*, 26 July 1890 (NEB). THURSTON CO.: *S. Stephens* 21119 (KANU).

Woodsia oregana D.C. Eat. Can. Nat. and Geol. N.S. 2:89. 1865.

Nebraska: BROWN CO.: *S. Stephens* 24459 and *R. Brooks* (KANU). CHERRY CO.: *W. L. Tolstead*, 25 June 1937 (NEB). CUSTER CO.: *A. J. Petrik-Ott* 786 (KANU). DAWES CO.: *S. Stephens* 5671 (KANU). GREELEY CO.: *R. Brooks* 463 and *S. Stephens* (KANU). ROCK CO.: *S. Stephens* 6916 (KANU). SCOTTS BLUFF CO.: *W. L. Tolstead*, 28 Aug. 1941 (NEB). SHERIDAN CO.: *S. Stephens* 6188 (KANU). SIOUX CO.: *R. Brooks* 475 and *S. Stephens* (KANU). THOMAS CO.: *P. A. Rydberg* 1479 (NEB).

North Dakota: BILLINGS CO.: *R. Brooks* 418 (KANU). GOLDEN VALLEY CO.: *S. Stephens* 23439 and *R. Brooks* (KANU). MCKENZIE CO.: *R. Brooks* 416 (KANU). MCLEAN CO.: *J. Lunell*, 18 June 1916 (NDA). MORTON CO.: *R. Brooks* 390 (KANU). SIOUX CO.: *R. Brooks* 385 (KANU).

South Dakota: CORSON CO.: *S. Stephens* and *R. Brooks* 383 (KANU). CUSTER CO.: *P. A. Rydberg* 1199 (NEB). FALL RIVER CO.: *A. Nelson* 681 (SDU). HARDING CO.: *S. Stephens* 7889 (KANU). LYMAN CO.: *R. Brooks* 376 and *S. Stephens* (KANU). MINNEHAHA CO.: *L. J. Harms* 2693 (KANU). PENNINGTON CO.: *R. L. McGregor* 18786 (KANU). STANLEY CO.: *R. Brooks* 378 and *S. Stephens* (KANU). WASHABAUGH CO.: *J. E. Bare* 1227 (KANU).

Woodsia scopulina D.C. Eat. Can. Nat. and Geol. N.S. 2:91. 1865.

South Dakota: CUSTER CO.: *A. J. Petrik-Ott* 785 (KANU). LAWRENCE CO.: *E. J. Palmer* 37556-A (UMO). PENNINGTON CO.: *S. Stephens* 7309 (KANU).

Family Aspleniaceae

Asplenium platyneuron (L.) Oakes ex D.C. Eat. Ferns N. Amer. 1:24. 1878.

Kansas: ATCHISON CO.: *H. W. Blocker* (KSC). BOURBON CO.: *R. L. McGregor* 974 (KANU). CHAUTAUQUA CO.: *A. J. Petrik-Ott* 742 (KANU). CHEROKEE CO.: *A. J. Petrik-Ott* 722 (KANU). COFFEY CO.: *R. L. McGregor* 909 (KANU). CRAWFORD CO.: *R. L. McGregor* 988 (KANU). DOUGLAS CO.: *R. L. McGregor* 660 (KANU). ELK CO.: *R. L. McGregor* 929 (KANU). FRANKLIN CO.: *R. L. McGregor* 899 (KANU). GREENWOOD CO.: *R. L. McGregor* 17208 (KANU). JOHNSON CO.: *R. L. McGregor* 898 (KANU). LABETTE CO.: *R. L. McGregor* 958 (KANU). LEAVENWORTH CO.: *A. J. Petrik-Ott* 749 (KANU). LINCOLN CO.: *P. H. Humfeld* 960 (KANU). MONTGOMERY CO.: *R. L. McGregor* 3396 (KANU). NEOSHO CO.: *R. L. McGregor* 956 (KANU). WILSON CO.: *R. L. McGregor* 935 (KANU). WOODSON CO.: *A. J. Petrik-Ott* 731 (KANU).

Asplenium resiliens Kunze, Linnaea 18:331. 1844.

Kansas: BOURBON CO.: *R. L. McGregor* 986 (KANU). CHAUTAUQUA CO.: *R. L. McGregor* 954 (KANU). CHEROKEE CO.: *R. L. McGregor* 11090 (KANU). ELK CO.: *R. L. McGregor* 938 (KANU). GREENWOOD CO.: *R. L. McGregor* 936 (KANU). LABETTE CO.: *R. L. McGregor* 969 (KANU). MONTGOMERY CO.: *W. H. Horr* E416 (KANU). WILSON CO.: *R. L. McGregor* 937 (KANU).

Asplenium septentrionale (L.) Hoffm. Deutsch. Fl. 2:12. 1795.

South Dakota: CUSTER CO.: *S. Stephens* and *R. Brooks* 429 (KANU). PENNINGTON CO.: *R. Brooks* 477 and *S. Stephens* (KANU).

Asplenium trichomanes L. Sp. Pl. 2:1080. 1753.

Kansas: CHAUTAUQUA CO.: *A. J. Petrik-Ott* 743 (KANU). GREENWOOD CO.: *R. L. McGregor* 3416 (KANU). WILSON CO.: *F. Agrelius*, 28 May 1930 (KSC). WOODSON CO.: *A. J. Petrik-Ott* 730 (KANU).

South Dakota: PENNINGTON CO.: *P. A. Rydberg* 1193 (NEB).

Asplenium viride Huds. Fl. Angl. 385. 1762.

South Dakota: LAWRENCE CO.: *S. Stephens* and *R. Brooks* 426 (KANU).

Camptosorus rhizophyllus (L.) Link, Hort. Berol. 2:69. 1833.

Kansas: ALLEN CO.: *R. L. McGregor* 3336 (KANU). ANDERSON CO.: *R. L. McGregor* 3458 (KANU). ATCHISON CO.: *S. Stephens* 10846 (KANU). BOURBON CO.: *A. J. Petrik-Ott* 758 (KANU). CHAUTAUQUA

CO.: *P. H. Humfeld* 843 (KANU). CHEROKEE CO.: *R. L. McGregor* 11163 (KANU). COFFEY CO.: *R. L. McGregor* 920 (KANU). COWLEY CO.: *W. H. Horr* and *R. L. McGregor*, 23 July 1947 (KANU). CRAWFORD CO.: *No collector given*, no date (KSC). DONIPHAN CO.: *F. Agrelius*, Aug. 1913 (KSTC). DOUGLAS CO.: *R. L. McGregor* 29 (KANU). ELK CO.: *R. L. McGregor* 939 (KANU). FRANKLIN CO.: *S. Stephens* 17463 (KANU). GREENWOOD CO.: *W. H. Horr*, 10 June 1939 (KANU). JOHNSON CO.: *R. L. McGregor* 2346 (KANU). LABETTE CO.: *R. L. McGregor* 959 (KANU). LEAVENWORTH CO.: *W. M. Keith* and *B. L. Wagenknecht* 2348 (KANU). LINN CO.: *A. J. Petrik-Ott* 764 (KANU). MIAMI CO.: *P. H. Humfeld* 158 (KANU). MONTGOMERY CO.: *A. J. Petrik-Ott* 737 (KANU). NEOSHO CO.: *R. L. McGregor* 960 (KANU). RILEY CO.: *G. L. Clothier*, 15 Sept. 1888 (KSC). WILSON CO.: *R. L. McGregor* 2370 (KANU). WOODSON CO.: *R. L. McGregor* 919 (KANU). WYANDOTTE CO.: *M. Reed*, 26 Sept. 1889 (KSC).

Family Blechnaceae

Matteuccia struthiopteris (L.) Tod. Syn. Pl. Acot. Vasc. Sicilia 30. 1866.

North Dakota: BOTTINEAU CO.: *D. R. Moir, L. D. Potter* and *O. A. Stevens* 2042 (NDA). CASS CO.: *O. A. Stevens*, 8 July 1922 (NDA). GRIGGS CO.: *No collector given*, 11 June 1953 (NDA). MORTON CO.: *O. A. Stevens*, 14 Aug. 1954 (NDA). PEMBINA CO.: *R. Brooks* 450 (KANU). RANSOM CO.: *O. A. Stevens*, 10 Sept. 1964 (NDA). RICHLAND CO.: *W. J. Wanek* 255 (NDA). ROLETTE CO.: *D. T. Disrud* 98 (NDA).

South Dakota: CUSTER CO.: *S. Stephens* 6105 (KANU). PENNINGTON CO.: *S. Stephens* 7117 (KANU). ROBERTS CO.: *A. J. Petrik-Ott* 799 (KANU).

Onoclea sensibilis L. Sp. Pl. 2:1062. 1753.

Kansas: ATCHISON CO.: *H. W. Blocker* 514 (KSC). CHAUTAUQUA CO.: *R. L. McGregor* 15046 (KANU). DONIPHAN CO.: *G. L. Clothier* and *H. N. Whitford*, 31 July 1897 (KSC). DOUGLAS CO.: *R. L. McGregor* 704 (KANU). GREENWOOD CO.: *S. Stephens* 9908 (KANU). JEFFERSON CO.: *R. L. McGregor* 4152 (KANU). JOHNSON CO.: *J. A. Gummerwan*, June 1888 (KSC). LEAVENWORTH CO.: *P. H. Humfeld* 270 (KANU). MONTGOMERY CO.: *W. H. Horr* and *R. L. McGregor* E421 (KANU). OTTAWA CO.: *C. T. Rogerson*, 4 June 1954 (KSC). SALINE CO.: *P. H. Humfeld* 448 (KANU). WOODSON CO.: *D. L. Marsh* 549 (KANU).

Nebraska: BROWN CO.: *S. Stephens* 24433 and *R. Brooks* (KANU). BUFFALO CO.: *Misses Smith* and *Lee*, 1894 (NEB). CHERRY CO.: *S.*

Stephens 8251 (KANU). FRANKLIN CO.: *E. M. Hussong* 6775 (NEB). HOLT CO.: *F. Clements* 2802 (NEB). JEFFERSON CO.: *R. A. Price* 7270 (NEB). LOUP CO.: *S. Stephens* 6832 (KANU). OTOE CO.: *C. Dunn*, March 1904 (NEB). SAUNDERS CO.: *No collector given*, 16 July 1889 (SDC). SHERIDAN CO.: *F. Sandoz* 366 (NEB). THOMAS CO.: *P. A. Rydberg* 1377 (NEB).

North Dakota: PEMBINA CO.: *O. A. Stevens* 1594 (NDA). RICHLAND CO.: *O. A. Stevens* 833 (NDA).

South Dakota: BENNETT CO.: *W. H. Over* 15886 (SDU). CUSTER CO.: *S. Stephens* 6016 (KANU). LAWRENCE CO.: *A. C. McIntosh* 558 (SDU). MINNEHAHA CO.: *W. H. Over* 11102 (SDU). PENNINGTON CO.: *A. J. Petrik-Ott* 793 (KANU). STANLEY CO.: *H. E. Lee* B154 (SDU).

Family Dennstaedtiaceae

Pteridium aquilinum (L.) Kuhn in v. d. Decken, Reisen in Ost-Afrika 3(3):11. 1879.

Kansas: CHEROKEE CO.: *R. L. McGregor* 3863 (KANU).

North Dakota: PEMBINA CO.: *R. Brooks* 454 (KANU).

South Dakota: CUSTER CO.: *P. A. Rydberg* 1192 (NEB). LAWRENCE CO.: *S. Stephens* 7717 (KANU).

Family Polypodiaceae

Polypodium polypodioides (L.) Watt var. **michauxianum** Weath., in Contr. Gray Herb. **124**:31. 1939.

Kansas: CHAUTAUQUA CO.: *R. L. McGregor* 3379 (KANU).

Polypodium vulgare L. Sp. Pl. **2**:1085. 1753.

South Dakota: CUSTER CO.: *A. J. Petrik-Ott* 790 (KANU). MINNEHAHA CO.: *L. J. Harms* 2688 (KANU). PENNINGTON CO.: *S. Stephens* 7227 (KANU). SHANNON CO.: *S. S. Visher*, 6 July 1923 (SDU).

Family Marsileaceae

Marsilea mucronata A. Br. Amer. Journ. Sci. 3:55. fig. 2. 1847.

Kansas: BARBER CO.: *R. L. McGregor* 10701 (KANU). BARTON CO.: *S. Stephens* and *R. Brooks* 357 (KANU). BUTLER CO.: *P. H. Humfeld* 798 (KANU). CHASE CO.: *R. L. McGregor* 3937 (KANU). CLARK CO.: *R. L. McGregor* 4024 (KANU). CLAY CO.: *S. Stephens* 29475 (KANU). CLOUD CO.: *S. V. Fraser* 560 (KSC). COFFEY CO.: *J. F. True*, 22 July 1938 (KSC). COWLEY CO.: *S. Stephens* 6583 (KANU). EDWARDS CO.:

W. A. Kellerman, 21 Aug. 1884 (KSC). ELLIS CO.: *R. L. McGregor* 3286 and *W. H. Horr* (KANU). FINNEY CO.: *R. L. McGregor* 3991 (KANU). FORD CO.: *R. L. McGregor* 3972 (KANU). GOVE CO.: *A. S. Hitchcock*, July 1895 (KSC). GRAHAM CO.: *G. L. Clothier*, Aug.-Sept. 1898 (KSC). GRAY CO.: *R. L. McGregor* 3270 and *W. H. Horr* (KANU). HARPER CO.: *R. L. McGregor* 13744 (KANU). HARVEY CO.: *R. L. McGregor* 3504 (KANU). HASKELL CO.: *R. L. McGregor* 4001 (KANU). HODGEMAN CO.: *R. L. McGregor* 3962 (KANU). KINGMAN CO.: *R. L. McGregor* 7313 (KANU). KIOWA CO.: *R. L. McGregor* 4951 (KANU). LANE CO.: *R. L. McGregor* 3278 and *W. H. Horr* (KANU). LYON CO.: *J. S. Wilson* 9749 (KSTC). MEADE CO.: *R. L. McGregor* 3256 and *W. H. Horr* (KANU). MORTON CO.: *E. L. Richards* 3571 (KANU). OSBORNE CO.: *J. Richardson* and *K. Robertson* 856 (KANU). PAWNEE CO.: *R. L. McGregor* 3951 (KANU). POTTAWATOMIE CO.: *O. A. Stevens*, 13 June 1909 (KSC). PRATT CO.: *W. T. Barker* 1809 (KANU). RENO CO.: *E. W. Lathrop* 2201 (KANU). REPUBLIC CO.: *J. B. S. Norton*, 23 Sept. 1895 (KSC). RICE CO.: *R. L. McGregor* 3943 (KANU). RUSH CO.: *A. S. Hitchcock*, Aug. 1895 (KSC). SALINE CO.: *F. H. Humfeld* 871 (KANU). SCOTT CO.: *A. S. Hitchcock*, Aug. 1895 (KSC). SEDGWICK CO.: *R. L. McGregor* 4047 (KANU). SEWARD CO.: *R. L. McGregor* 4010 (KANU). SHERIDAN CO.: *C. Weber* 299 (KSC). SHERMAN CO.: *A. S. Hitchcock*, June 1892 (KSC). STAFFORD CO.: *I. Ungar* 629 (KANU). STANTON CO.: *F. Lagergren*, 20 July 1951 (KSC). STEVENS CO.: *R. L. McGregor* 17015 (KANU). TREGO CO.: *J. L. Hutchison*, 14 Aug. 1951 (KSC). WALLACE CO.: *A. S. Hitchcock*, Aug. 1895 (KSC). WASHINGTON CO.: *R. L. McGregor* 1000 (KANU). WICHITA CO.: *Agrelius, Hall, Lovejoy*, 1913 (KANU).

Nebraska: ANTELOPE CO.: *N. F. Petersen*, June 1909 (NEB). BOX BUTTE CO.: *W. L. Tolstead*, 28 Aug. 1941 (NEB). CHASE CO.: *W. L. Tolstead*, 4 Aug. 1941 (NEB). CLAY CO.: *W. Kiener* 22538 (NEB). CUSTER CO.: *J. M. Bates* 2246 (NEB). DAWES CO.: *J. M. Bates*, 29 July 1890 (NEB). DEUEL CO.: E. M. Gilliard, 3 July 1893 (NEB). DUNDY CO.: *W. Kiener* 10513 (NEB). FILLMORE CO.: *W. L. Tolstead*, 21 July 1941 (NEB). FRANKLIN CO.: *W. L. Tolstead*, 5 Sept. 1941 (NEB). GOSPER CO.: *W. Kiener* 19386 (NEB). HALL CO.: *R. Brooks* 465 and *S. Stephens* (KANU). HAMILTON CO.: *W. Kiener* 17847 (NEB). HARLAN CO.: *W. L. Tolstead*, 5 Sept. 1941 (NEB). HAYES CO.: *W. L. Tolstead*, 7 Aug. 1941 (NEB). JEFFERSON CO.: *E. F. Lange*, 3 Sept. 1892 (NEB). KEARNEY CO.: *P. A. Rydberg* 6604 (NEB). LANCASTER CO.: *J. M. Bates*, 4 Aug. 1898 (NEB). MERRICK CO.: *I. Mueller*, 14 July 1938 (NEB). PERKINS CO.: *W. L. Tolstead*, 7 Aug. 1941 (NEB). PHELPS CO.: *R. J. Lemaire* 1499 (NEB). PIERCE CO.: *N. F. Petersen*, 2 July 1907 (NEB). SHERIDAN CO.: *W. L. Tolstead*, 25 Aug. 1941 (NEB). WEBSTER CO.: *J. M. Bates*, no date (NEB). WHEELER CO.: *R. Brooks* 791 (KSTC).

North Dakota: BARNES CO.: *O. A. Stevens* 1223 (NDA). BENSON CO.: *J. Lunell*, 10 Sept. 1905 (NDA). BOTTINEAU CO.: *R. Smith*, 20 Sept. 1912 (NDA). BOWMAN CO.: *O. A. Stevens*, 4 July 1949 (NDA). BURLEIGH CO.: *S. Stephens* 33268 and *R. Brooks* (KANU). FOSTER CO.: *O. A. Stevens* and *W. A. Kluender*, 21 Aug. 1935 (NDA). GRANT CO.: *W. B. Bell* 1355 (NDA). KEDDER CO.: *O. A. Stevens* and *D. R. Moir*, 22 Aug. 1956 (NDA). MCLEAN CO.: *O. A. Stevens*, 27 Aug. 1915 (NDA). MOUNTRAIL CO.: *O. A. Stevens*, 20 Aug. 1915 (NDA). RAMSEY CO.: *C. A. Geyer* 71 (MO). SLOPE CO.: *A. C. Fox*, 26 July 1938 (NDA). WALSH CO.: *A. C. Fox*, July 1938 (NEB). WARD CO.: *L. F. Lantenschlager* 847 (NDA).

South Dakota: BROOKINGS CO.: *T. A. Williams*, Sept. 1893 (MO). BROWN CO.: *R. L. McGregor* 18733 (KANU). BUTTE CO.: *A. Nelson* 549 (SDU). CHARLES MIX CO.: *J. Martin*, 22 July 1965 (SDU). CLARK CO.: *Carter*, Sept. 1896 (SDC). CUSTER CO.: *A. Nelson*, 2 Sept. 1926 (SDU). DAVISON CO.: *Dillman*, 25 Aug. 1907 (SDC). HANSON CO.: *R. Brooks* 435 (KANU). HARDING CO.: *S. Stephens* and *R. Brooks* 423 (KANU). HUGHES CO.: *J. Martin*, 24 July 1965 (SDU). HYDE CO.: *R. Brooks* 460 (KANU). PERKINS CO.: *S. S. Visher* 7084 (SDU). SANBORN CO.: *W. H. Over*, 3 June 1921 (SDU). STANLEY CO.: *W. H. Over* 7082 (SDU). WASHABAUGH CO.: *S. S. Visher* 7083 (SDU).

Marsilea quadrifolia L. Sp. Pl. **2**:1099. 1753.

Kansas: CHEROKEE CO.: *O. A Kolstad* and *L. J. Harms* 1581 (KANU). NEOSHO CO.: *W. W. Holland* 1993 (KANU).

Pilularia americana A. Br. Monatsber. Akad. Berl. **1863**: 435. 1864.

Kansas: HARVEY CO.: *R. Brooks* 467 and *S. Stephens* (KANU). RENO CO.: *R. L. McGregor* 3933 (KANU).

Nebraska: CHERRY CO.: *R. L. McGregor* 20017 (KANU).

Family Azollaceae

Azolla mexicana Presl, Abh. Bohm. Ges. Wiss. V. **3**:150. 1845.

Kansas: BARBER CO.: *R. L. McGregor* 14705 (KANU). BARTON CO.: *R. L. McGregor* 5198 (KANU). COFFEY CO.: *L. K. Magrath* 3291-1 (KSTC). DOUGLAS CO.: *R. L. McGregor* 4687 (KANU). JEFFERSON CO.: *R. L. McGregor* 4166 (KANU). LINN CO.: *O. A. Kolstad* and *L. J. Harms* 2690 (KANU). LYON CO.: *E. E. Garner* 1110 (KSTC). NEOSHO CO.: *W. W. Holland* 732 (KANU).

Nebraska: FILLMORE CO.: *W. Kiener* 22552 (NEB). GARDEN CO.: *W. Kiener* 23131 (NEB). KEITH CO.: *W. Kiener* 23066 (NEB). SEWARD CO.: *W. L. Tolstead*, 18 Aug. 1941 (NEB). THOMAS CO.: *A. J. Petrik-Ott* 781 (KANU).

THE FERN ALLIES

Family Equisetaceae

Equisetum arvense L. Sp. Pl. 2:1061. 1753.

Kansas: ATCHISON CO.: *R. L. McGregor* 2807 (KANU). BROWN CO.: *Garner*, Summer 1925 (KSC). CLAY CO.: *Weber* 409 (KSC). CLOUD CO.: *S. V. Fraser* 561 (KSC). DONIPHAN CO.: *A. J. Petrik-Ott* 754 (KANU). DOUGLAS CO.: *R. L. McGregor* 4234 (KANU). JACKSON CO.: *R. L. McGregor* 2844 (KANU). JEFFERSON CO.: *R. L. McGregor* 4153 (KANU). JOHNSON CO.: *R. L. McGregor* 3430 (KANU). LEAVENWORTH CO.: *R. L. McGregor* 3074 (KANU). MARSHALL CO.: *Stephens* 4701 (KANU). POTTAWATOMIE CO.: *P. H. Humfeld* 969 (KANU). RILEY CO.: *F. C. Gates* 15756 (KSC). SALINE CO.: *J. Hancin* 1255 (KSC). SHAWNEE CO.: *B. B. Smyth* 77 (KSC). WABAUNSEE CO.: *T. M. Barkley*, 1 May 1963 (KANU). WASHINGTON CO.: *T. C. Dodd, Jr.* 145 (KSC). WOODSON CO.: *E. W. Lathrop* 2190 (KANU). WYANDOTTE CO.: *P. H. Humfeld* 1021 (KANU).

Nebraska: BLAINE CO.: *S. Stephens* 24398 and *R. Brooks* (KANU). BOX BUTTE CO.: *C. H. Churchill*, 5 July 1906 (NEB). BOYD CO.: *W. T. Barker* 3059 (KANU). BROWN CO.: *J. M. Bates*, 25 June 1892 (NEB). BUFFALO CO.: *S. Stephens* 6767 (KANU). BURT CO.: *S. Stephens* 32067 and *R. Brooks* (KANU). CASS CO.: *S. Stephens* 3768 (KANU). CEDAR CO.: *R. Brooks* 433 (KANU). CHERRY CO.: *R. L. McGregor* 19734 (KANU). CUMING CO.: *S. Stephens* 36390 (KANU). DAWES CO.: *S. Stephens* 5578 (KANU). DODGE CO.: *L. Magrath* 2615 (KSTC). DOUGLAS CO.: *W. Cleburne*, 23 May 1875 (NEB). GREELY CO.: *R. L. McGregor* and *J. E. Bare* 430 (KANU). HALL CO.: *R. J. Lemaire* 2064 (NEB). HOLT CO.: *J. M. Bates*, 22 June 1898 (NEB). HOOKER CO.: *S. Stephens* 17232 and *R. Brooks* (KANU). HOWARD CO.: *J. E. Bare* 390 and *R. L. McGregor* (KANU). KEYA PAHA CO.: *S. Stephens* 6934 (KANU). LANCASTER CO.: *Pound, Clements*, and *Saunders*, 2 May 1893 (NEB). LINCOLN CO.: *S. Stephens* 15995 and *R. Brooks* (KANU). LOGAN CO.: *S. Stephens* 25068 and *R. Brooks* (KANU). NANCE CO.: *R. J. Lemaire* 1971 (NEB). NEMAHA CO.: *A. E. Watts*, 5 May 1894 (SDU). OTOE CO.: *Pound* and *Clements* 4067 (NEB). RICHARDSON CO.: *S. Stephens* 3563 (KANU). SARPY CO.: *Pound* and *Saunders* 4097 (NEB). SAUNDERS CO.: *J. E. Weaver*, May 1936 (NEB). SEWARD CO.: *H. J. Webber* 6138 (NEB). SHERIDAN CO.: *S. Stephens* 6290 (KANU). SHERMAN CO.: *R. L. McGregor* 19801 (KANU). SIOUX CO.: *S. Stephens* 16364 and *R. Brooks* (KANU). THOMAS CO.: *P. A. Rydberg* 1378 (NEB). THURSTON CO.: *S. Stephens* 21118 (KANU). WEBSTER CO.: *R. L. McGregor* and *J. E. Bare* 792 (KANU).

North Dakota: BARNES CO.: *H. F. Bergman* 373 (NDA). BENSON CO.: *R. Brooks* 457 (KANU). BILLINGS CO.: *O. A. Stevens*, 21 June

1961 (NDA). BOTTINEAU CO.: *R. Brooks* 402 (KANU). BURKE CO.: *R. Brooks* 405 (KANU). CASS CO.: *H. F. Bergman*, 17 June 1909 (NDA). CAVALIER CO.: *O. A. Stevens*, 13 June 1956 (NDA). DIVIDE CO.: *R. Brooks* 407 (KANU). DUNN CO.: *R. Brooks* 397 (KANU). EDDY CO.: *O. A. Stevens* and *D. R. Moir*, 10 Sept. 1956 (NDA). GRAND FORKS CO.: *V. Facey*, 14 July 1960 (NDA). GRIGGS CO.: *O. A. Stevens*, 30 July 1965 (NDA). LAMOURE CO.: *J. F. Brenckle*, 1905 (NDA). MCHENRY CO.: *O. A. Stevens*, 16 June 1956 (NDA). MCKENZIE CO.: *W. B. Bell* 1038 (NDA). MOUNTRAIL CO.: *O. A. Stevens* and *D. R. Moir*, 13 Sept. 1956 (NDA). MORTON CO.: *O. A. Stevens*, 25 July 1967 (NDA). PEMBINA CO.: *R. Brooks* 446 (KANU). RANSOM CO.: *W. B. Bell* 290 (NDA). RICHLAND CO.: *R. Brooks* 445 (KANU). ROLETTE CO.: *D. T. Disrud* 1952 (NDA). SIOUX CO.: *A. J. Petrik-Ott* 796 (KANU). STARK CO.: *O. A. Stevens*, 17 Aug. 1954 (NDA). STEELE CO.: *O. A. Stevens*, 7 July 1966 (NDA). WARD CO.: *L. F. Lautenschlager* 425 (NDA). WILLIAMS CO.: *R. Brooks* 413 (KANU).

South Dakota: BROOKINGS CO.: *D. Saunders*, May 1897 (SDC). BUFFALO CO.: *S. Stephens* 32969 and *R. Brooks* (KANU). CLAY CO.: *W. H. Over* 11012 (SDU). CODINGTON CO.: *J. R. Dugle* 875 (SDU). CORSON CO.: *S. Stephens* and *R. Brooks* 381 (KANU). CUSTER CO.: *S. Stephens* 6107 (KANU). DEUEL CO.: *D. Saunders* 8016 (SDU). HAND CO.: *J. E. Todd* 16820 (SDU). HARDING CO.: *S. Stephens* and *R. Brooks* 424 (KANU). LAWRENCE CO.: *S. Stephens* 7578 (KANU). LINCOLN CO.: *L. J. Harms* 2604 (KANU). MARSHALL CO.: *T. Van Bruggen* 446 (SDU). MINNEHAHA CO.: *C. A. Taylor* 9348 (SDU). MOODY CO.: *C. A. Taylor* and *R. Lowell* 10251 (SDC). PENNINGTON CO.: *S. Stephens* 7216 (KANU). ROBERTS CO.: *A. J. Petrik-Ott* 798 (KANU). SANBORN CO.: *S. S. Visher* 4445 (SDU). UNION CO.: *L. J. Harms* 2384 (KANU). YANKTON CO.: *L. J. Harms* 2832 (KANU).

Equisetum × ferrissii Clute, Fern Bull. 12:22. 1904.

Kansas: ATCHISON CO.: *R. L. McGregor* 2809 (KANU). BARTON CO.: *R. L. McGregor* 3944 (KANU). BROWN CO.: *W. H. Horr*, 10 July 1947 (KANU). CHAUTAUQUA CO.: *B. L. Wagenknecht* 1830 (KANU). CHEROKEE CO.: *E. L. Richards* 3124 (KANU). CHEYENNE CO.: *R. L. McGregor* 13582 (KANU). COWLEY CO.: *W. T. Barker* 3657 (KANU). DONIPHAN CO.: *B. L. Wagenknecht* 3341 (KANU). DOUGLAS CO.: *E. B. Smith* 412 (KANU). EDWARDS CO.: *A. S. Hitchcock*, 1 Sept. 1897 (KSC). ELLSWORTH CO.: *R. L. McGregor* 12393 (KANU). JACKSON CO.: *R. L. McGregor* 2839 (KANU). JEFFERSON CO.: *Hartman* 1082 (KANU). LEAVENWORTH CO.: *Hartman* 1084 (KANU). LINCOLN CO.: *P. H. Humfeld* 957 (KANU). LINN CO.: *R. L. McGregor* 3467 (KANU). MEADE CO.: *R. L. McGregor* 4016 (KANU). NEOSHO CO.: *W. W. Holland* 2506 (KANU). POTTAWATOMIE CO.: *S. Stephens* 4767 (KANU). PRATT CO.: *W. T. Barker* 1574 (KANU). RENO CO.: *R. L.*

McGregor 12476 (KANU). REPUBLIC CO.: *D. K. Thomas*, 1890 (KSC). RILEY CO.: *No collector given*, 1 July 1889 (MO). ROOKS CO.: *E. Bartholomew*, 25 June 1890 (NEB). SALINE CO.: *P. H. Humfeld* 446 (KANU). SHAWNEE CO.: *Hartman* 1088 (KANU). TREGO CO.: *M. Reed* and *A. S. G.*, 8 July 1892 (KSC). WABAUNSEE CO.: *S. L. Hunt* 13 (KSTC). WASHINGTON CO.: *W. H. Horr* 4640 (KANU). WICHITA CO: *F. Agrelius*, no date given (KSTC). WILSON CO.: *W. H. Haller*, 16 June 1896 (KSC). WOODSON CO.: *S. Stephens* 8383 (KANU). WYANDOTTE CO.: *Hartman* 1090 (KANU).

Nebraska: BROWN CO.: *S. Stephens* 24439 and *R. Brooks* (KANU). BUFFALO CO.: *R. L. McGregor* and *J. E. Bare* 1656 (KANU). CASS CO.: *S. Stephens* 3771 (KANU). CEDAR CO.: *S. Stephens* 31978 and *R. Brooks* (KANU). CHERRY CO.: *S. Stephens* 8167 (KANU). CUSTER CO.: *J. M. Bates* 2354 (NEB). DAKOTA CO.: *S. Stephens* 32054 and *R. Brooks* (KANU). DAWES CO.: *H. J. Webber* 6134 (NEB). DIXON CO.: *F. Clements* 2543 (NEB). DODGE CO.: *L. Magrath* 2616 (KSTC). DOUGLAS CO.: *W. Cleburne*, 8 July 1890 (NEB). DUNDY CO.: *A. F. Woods* and *D. Saunders* 2000 (NEB). HALL CO.: *R. J. Lemaire* 2456 (NEB). HOLT CO.: *J. M. Bates*, 2 Aug. 1892 (NEB). KEARNEY CO.: *P. A. Rydberg* 475 (NEB). SARPY CO.: *W. Cleburne*, 10 July 1897 (NEB). SIOUX CO.: *W. L. Tolstead*, 13 July 1940 (NEB). STANTON CO.: *R. Brooks* 432 (KANU). THOMAS CO.: *H. J. Webber* 6131 (NEB). VALLEY CO.: *S. Stephens* 15620 and *R. Brooks* (KANU). WEBSTER CO.: *J. M. Bates*, July 1903 (NEB).

North Dakota: BARNES CO.: *H. F. Bergman* 248 (NDA). BENSON CO.: *J. Lunell*, 15 Aug. 1915 (NDA). CASS CO.: *O. A. Stevens* 1083 (NDA). EMMONS CO.: *R. Brooks* 458 (KANU). GRIGGS CO.: *O. A. Stevens*, 30 July 1965 (NDA). MCHENRY CO.: *O. A. Stevens*, 21 July 1966 (NDA). MCINTOSH CO.: *R. Brooks* 459 (KANU). MORTON CO.: *O. A Stevens*, 6 Aug. 1938 (NDA). PEMBINA CO.: *R. Brooks* 451 (KANU). RANSOM CO.: *W. B. Bell*, 3 July 1909 (NDA). RICHLAND CO.: *R. Brooks* 444 (KANU). WARD CO.: *L. F. Lautenschlager* 658 (NDA). WILLIAMS CO.: *O. A. Stevens*, 14 Aug. 1941 (NDA).

South Dakota: JACKSON CO.: *W. H. Over* 7103 (SDU). MEADE CO.: *Snyder* 307 (SDC). PENNINGTON CO.: *A. Nelson* 514 (SDU). TURNER CO.: *L. Messerli* 532 (SDU). UNION CO.: *L. J. Harms* 2390 (KANU). WASHABAUGH CO.: *S. S. Visher* 207099 (SDU).

Equisetum fluviatile L. Sp. Pl. 2:1062. 1753.

Nebraska: DOUGLAS CO.: *E. R. Walker*, 25 May 1940 (NEB). GARFIELD CO.: *J. M. Bates* 4917 (NEB). HOLT CO.: *J. M. Bates*, 27 June 1892 (NEB). SARPY CO.: *W. L. Tolstead* 41594 (NEB).

North Dakota: BENSON CO.: *J. Lunell*, 30 June 1908 (NDA). BOTTINEAU CO.: *S. Stephens* 28846 (KANU). MCHENRY CO.: *J. Lunell*, 24 June 1908 (NDA). PEMBINA CO.: *L. R. Waldron* 1604 (NDA). RICHLAND CO.: *O. A. Stevens*, 11 July 1934 (NDA). ROLETTE CO.:

D. T. Disrud and *D. Disrud* 347 (NDA). WARD CO.: *L. F. Lautenschlager* 783 (NDA).

South Dakota: GRANT CO.: *D. Saunders* and *J. R. Towne*, Aug. 1897 (SDC).

Equisetum hyemale L. var. **affine** (Engelm.) A. A. Eat. Fern Bull. **11**:111. 1903.

Kansas: ALLEN CO.: *B. Osborn* 643R (KSC). ATCHISON CO.: *R. L. McGregor* 2733 (KANU). CHEROKEE CO.: *R. L. McGregor* 2734 (KANU). CLAY CO.: *C. Weber* 316 (KSC). DONIPHAN CO.: *S. Stephens* 9349 (KANU). DOUGLAS CO.: *P. H. Humfeld* 153 (KANU). ELLSWORTH CO.: *S. Stephens* 17033 (KANU). FRANKLIN CO.: *E. Hartman* 644 (KANU). GREENWOOD CO.: *R. L. McGregor* 12339 (KANU). JACKSON CO.: *R. L. McGregor* 2843 (KANU). JEFFERSON CO.: *P. H. Humfeld* 138 (KANU). JOHNSON CO.: *R. L. McGregor* 3429 (KANU). LEAVENWORTH CO.: *P. H. Humfeld* 196 (KANU). LINN CO.: *S. Stephens* 30999 (KANU). MARION CO.: *M. H. Bartel*, 14 Oct. 1960 (KSC). MARSHALL CO.: *S. Stephens* 3316 (KANU). REPUBLIC CO.: *G. E. Morley* 742 (KANU). RILEY CO.: *F. C. Gates* and *M. Newcomb*, 24 May 1928 (KANU). SUMNER CO.: *G. L. Clothier* and *H. N. Whitford*, 23 Aug. 1897 (KSC). WASHINGTON CO.: *W. H. Horr* 4640 (KANU). WILSON CO.: *H. Willis* 7 (KSTC). WOODSON CO.: *E. W. Lathrop* 407 (KANU). WYANDOTTE CO.: *A. J. Petrik-Ott* 746 (KANU).

Nebraska: BUFFALO CO.: *J. J. Thornbrer* 54 (NEB). BURT CO.: *S. Stevens* 21036 (KANU). CASS CO.: *J. L. Morrison* 935 (NEB). CHERRY CO.: *W. L. Tolstead*, 24 Aug. 1941 (NEB). DAWES CO.: *W. L. Tolstead*, 25 Aug. 1941 (NEB). DOUGLAS CO.: *W. Cleburne*, 8 Aug. 1902 (NEB). FRANKLIN CO.: *J. M. Bates*, 9 June 1891 (NEB). HARLAN CO.: *R. L. McGregor* 19531 (KANU). NEMAHA CO.: *S. Stephens* 17706 (KANU). RICHARDSON CO.: *A. J. Petrik-Ott* 772 (KANU). SIOUX CO.: *A. J Petrik-Ott* 782 (KANU). THOMAS CO.: *P. A. Rydberg* 1722 (NEB). THURSTON CO.: *S. Stephens* 21117 (KANU).

North Dakota: CASS CO.: *O. A. Stevens* 2834 (NDA). DICKEY CO.: *J. E. Bare* 860 and *R. L. McGregor* (KANU). EDDY CO.: *O. A. Stevens*, 13 June 1960 (NDA). GRAND FORKS CO.: *O. A. Stevens*, 16 June 1953 (NDA). MCHENRY CO.: *O. A. Stevens*, 16 June 1956 (NDA). PEMBINA CO.: *O. A. Stevens* and *D. R. Moir*, 13 June 1958 (NDA). RANSOM CO.: *S. Stephens* 33487 and *R. Brooks* (KANU). RICHLAND CO.: *A. D. Stoesz*, 2 June 1934 (NDA).

South Dakota: CUSTER CO.: *S. Stephens* 5993 (KANU). DEUEL CO.: *D. Saunders* 8015 (SDC). HARDING CO.: *S. S. Visher* 7098 (SDU). LAWRENCE CO.: *S. Stephens* 7424 (KANU). PENNINGTON CO.: *S. Stephens* 7217 (KANU). ROBERTS CO.: *R. Brooks* 440 and *S. Stevens* (KANU). SHANNON CO.: *S. S. Visher*, 27 June 1916 (SDU). UNION CO.: *R. Eslick*, 8 July 1961 (SDU). YANKTON CO.: *S. Stephens* 21229 (KANU).

Equisetum laevigatum A. Br. Amer. Journ. Sci. 46:87. 1844.

Kansas: ANDERSON CO.: *B. Neill* 285 (KSTC). BARBER CO.: *W. T. Barker* 799 (KANU). BARTON CO.: *H. A. Stephens*, 12 June 1958 (KSTC). BUTLER CO.: *R. R. Weedon* and *L. K. Magrath* 4204 (KANU). CHEYENNE CO.: *H. A. Stephens*, 14 June 1958 (KSTC). CLARK CO.: *R. L. McGregor* 4025 (KANU). CLAY CO.: *R. L. McGregor* 2076 (KANU). COWLEY CO.: *D. E. Dallas* 578 (KANU). DECATUR CO.: *W. H. Horr* 5046 (KANU). DICKINSON CO.: *Hartman* 1064 (KANU). DONIPHAN CO.: *Hartman* 1066 (KANU). DOUGLAS CO.: *R. L. McGregor* 3027 (KANU). ELLSWORTH CO.: *R. L. McGregor* 17107 (KANU). FINNEY CO.: *R. L. McGregor* 4000 (KANU). GEARY CO.: *Hartman* 1072 (KANU). HAMILTON CO.: *E. L. Richards* 3012 (KANU). HARPER CO.: *E. J. Palmer* 21201 (UMO). HARVEY CO.: *W. H. Horr* and *R. L. McGregor* 3724 (KANU). HODGEMAN CO.: *R. L. McGregor* 5188 (KANU). JEFFERSON CO.: *G. Latham* 380 (KANU). KINGMAN CO.: *R. L. McGregor* 7306 (KANU). KIOWA CO.: *R. L. McGregor* and *W. H. Horr* 3832 (KANU). LEAVENWORTH CO.: *Hartman* 1085 (KANU). LOGAN CO.: *S. Stephens* 31297 and *R. Brooks* (KANU). MARION CO.: *P. H. Humfeld* 790 (KANU). MARSHALL CO.: *S. Stephens* 3337 (KANU). MCPHERSON CO.: *L. J. Harms* 1054 (KANU). MEADE CO.: *W. H. Horr* and *R. L. McGregor* 4053 (KANU). MORTON CO.: *E. L. Richards* 2499 (KANU). OTTAWA CO.: *W. T. Barker* 2545 (KANU). POTTAWATOMIE CO.: *Hartman* 1086 (KANU). PRATT CO.: *W. T. Barker* 1611 (KANU). RENO CO.: *E. Hartman* 889 (KANU). REPUBLIC CO.: *G. E. Morley* 190 (KANU). RICE CO.: *R. L. McGregor* 12563 (KANU). RILEY CO.: *P. Zavos* 29 (KSTC). SALINE CO.: *Hartman* 1074 (KANU). SCOTT CO.: *R. L. McGregor* 13007 (KANU). SEDGWICK CO.: *M. A. Carleton*, 27 May 1889 (KSC). SHAWNEE CO.: *Hartman* 1078 (KANU). SHERMAN CO.: *O. A. Kolstad* and *L. J. Harms* 1822 (KANU). STAFFORD CO.: *I. Ungar* 511 (KANU). SUMNER CO.: *J. W. Johnson* 75 (KSTC). TREGO CO.: *S. Stephens* 31211 and *R. Brooks* (KANU). WALLACE CO.: *R. L. McGregor* 18579 (KANU). WICHITA CO.: *Agrelius* and *Agrelius*, 22 Aug. 1912 (KANU). WOODSON CO.: *W. H. Horr*, 10 July 1930 (KANU).

Nebraska: BOYD CO.: *R. L. McGregor* 19402 (KANU). BOX BUTTE CO.: *C. H. Churchill*, 5 July 1906 (NEB). BROWN CO.: *J. M. Bates*, June 1893 (NEB). BURT CO.: *S. Stephens* 32066 and *R. Brooks* (KANU). CASS CO.: *S. Stephens* 32146 and *R. Brooks* (KANU). CEDAR CO.: *R. Brooks* 434 (KANU). CHASE CO.: *J. E. Bare* 1403 and *R. L. McGregor* (KANU). CHERRY CO.: *S. Stephens* 8225 (KANU). CUSTER CO.: *A. J. Petrik-Ott* 780 (KANU). DAKOTA CO.: *S. Stephens* 32035 and *R. Brooks* (KANU). DAWES CO.: *S. Stephens* 5565 (KANU). DAWSON CO.: *R. L. McGregor* and *J. E. Bare* 1619 (KANU). DIXON CO.: *F. Clements* 2542 (NEB). DODGE CO.: *W. Kiener* 29692 (NEB). DOUGLAS CO.: *W. Kiener* 24571 (NEB). DUNDY CO.: *S. Stephens* and

R. Brooks 358 (KANU). GARDEN CO.: *S. Stephens* and *R. Brooks* 359 (KANU). GRANT CO.: *R. L. McGregor* 19682 (KANU). HALL CO.: *R. J. Lemaire* 1559 (NEB). HOOKER CO.: *P. A. Rydberg* 1801 (NEB). KEARNEY CO.: *S. Stephens* 6722 (KANU). KEITH CO.: *S. Stephens* and *R. Brooks* 361 (KANU). KEYA PAHA CO.: *S. Stephens* 34319 and *R. Brooks* (KANU). KNOX CO.: *S. Stephens* and *R. Brooks* 373 (KANU). LANCASTER CO.: *W. Kiener* 29597 (NEB). LINCOLN CO.: *S. Stephens* 15947 and *R. Brooks* (KANU). LOUP CO.: *S. Stephens* 6901 (KANU). MADISON CO.: *W. Kiener* 29715 (MO). MCPHERSON CO.: *S. Stephens* 24986 and *R. Brooks* (KANU). NANCE CO.: *B. Osborn* 1168R (MO). NEMAHA CO.: *J. W. Gehling*, 18 April 1935 (SDU). OTOE CO.: *B. Osborn* 815R (MO). PHELPS CO.: *S. Stephens* 24268 and *R. Brooks* (KANU). RICHARDSON CO.: *S. Stephens* 3596 (KANU). SARPY CO.: *W. Cleburne*, 21 May 1879 (NEB). SAUNDERS CO.: *T. B. Croat* 2119 (KANU). SCOTT BLUFF CO.: *S. Stephens* and *R. Brooks* 363 (KANU). SHERIDAN CO.: *S. Stephens* and *R. Brooks* 430 (KANU). SHERMAN CO.: *W. T. Barker* 2889 (KANU). SIOUX CO.: *S. Stephens* 16397 and *R. Brooks* (KANU). THOMAS CO.: *R. L. McGregor* 19651 (KANU). WEBSTER CO.: *R. L. McGregor* 18642 (KANU). WHEELER CO.: *W. T. Barker* 2955 (KANU).

North Dakota: BARNES CO.: *O. A. Stevens* 1218 (NDA). BENSON CO.: *J. Lunell*, 3 July 1910 (NDA). BILLINGS CO.: *R. Brooks* 420 (KANU). BOTTINEAU CO.: *O. A. Stevens*, 15 July 1966 (NDA). BURLEIGH CO.: *S. Stephens* 33250 and *R. Brooks* (KANU). CASS CO.: *Lee* 1205 (NDA). DICKEY CO.: *J. E. Bare* 859 and *R. L. McGregor* (KANU). DUNN CO.: *R. Brooks* 396 (KANU). EDDY CO.: *O. A. Stevens*, 13 July 1966 (NDA). EMMONS CO.: *O. A. Stevens* 825 (NDA). GOLDEN VALLEY CO.: *O. A. Stevens*, 11 July 1962 (NDA). GRAND FORKS CO.: *J. D. Walp*, 19 June 1936 (NDA). GREGORY CO.: *S. Stephens* 34071 and *R. Brooks* (KANU). HETTINGER CO.: *O. A. Stevens* and *W. A. Kluender* 137 (NDA). LAMOURE CO.: *J. E. Bare* 922 and *R. L. McGregor* (KANU). MCHENRY CO.: *J. E. Bare* 1039 and *R. L. McGregor* (KANU). MCKENZIE CO.: *O. A. Stevens* 1625 (NDA). MCLEAN CO.: *V. Rudd*, 11 July 1958 (NDA). MERCER CO.: *R. Brooks* 393 (KANU). MORTON CO.: *S. Stephens* 33614 and *R. Brooks* (KANU). MOUNTRAIL CO.: *J. E. Bare* 1128 and *R. L. McGregor* (KANU). RANSOM CO.: *O. A. Stevens*, 7 July 1959 (NDA). RICHLAND CO.: *O. A. Stevens* 98 (NDA). SARGENT CO.: *H. L. Bulley*, 10 June 1891 (NDA). SHERIDAN CO.: *O. A. Stevens*, 9 July 1959 (NDA). SIOUX CO.: *R. Brooks* 388 (KANU). SLOPE CO.: *R. Brooks* 422 (KANU). STARK CO.: *O. A. Stevens*, 17 Aug. 1954 (NDA). STEELE CO.: *O. A. Stevens*, 7 July 1966 (NDA). STUTSMAN CO.: *H. F. Bergman* 89 (NDA). WARD CO.: *R. Brooks* 401 (KANU). WILLIAMS CO.: *O. A. Stevens*, 20 June 1945 (NDA).

South Dakota: BEADLE CO.: *C. A. Treadwell* 104 (NEB). BROOKINGS CO.: *W. T. Barker* 2697 (KANU). BUTTE CO.: *W. H. Over* 17433 (SDU). CAMPBELL CO.: *L. A. Hanna* 128 (MO). CLAY CO.: *W. H. Over* 7104 (SDU). CODINGTON CO.: *J. E. Dugle* 109 (SDU). CORSON CO.: *S. Stephens* and *R. Brooks* 382 (KANU). CUSTER CO.: *S. Stephens* 6064 (KANU). FALL RIVER CO.: *S. Stephens* 5790 (KANU). HAMLIN CO.: *R. Brooks* 436 and *S. Stephens* (KANU). HARDING CO.: *S. Stephens* 7841 (KANU). HUTCHISON CO.: *V. L. Harms* 454 (KANU). LAWRENCE CO.: *S. Stephens* 7401 (KANU). LINCOLN CO.: *L. Messerli* 321 (SDU). MEADE CO.: *S. Stephens* 8097 (KANU). MINNEHAHA CO.: *C. A. Taylor* 9349 (SDC). MOODY CO.: *J. H. Wilde* and *C. A. Taylor* 9287 (SDC). PENNINGTON CO.: *S. Stephens* 7118 (KANU). PERKINS CO.: *S. Stephens* 8029 (KANU). ROBERTS CO.: *R. Brooks* 441 and *S. Stephens* (KANU). SULLY CO.: *S. Stephens* 33077 and *R. Brooks* (KANU). TODD CO.: *L. Stanley* 199 (SDU). TRIPP CO.: *S. Stephens* 34119 and *R. Brooks* (KANU). UNION CO.: *R. Eslick*, 17 June 1962 (SDU). WASHABAUGH CO.: *S. S. Visher* 7101 (SDU). YANKTON CO.: *L. J. Harms* 2533 (KANU).

Equisetum palustre L. Sp. Pl. 2:1061. 1753.

North Dakota: RANSOM CO.: *R. Brooks* 1554 and *S. Stephens* 33495 (KANU).

Equisetum pratense Ehrh. Hannov. Mag. 22:138. 1784.

North Dakota: PEMBINA CO.: *R. Brooks* 448 (KANU).

South Dakota: LAWRENCE CO.: *S. Stephens* 7544 (KANU). PENNINGTON CO.: *R. Brooks* 481 and *S. Stephens* (KANU). ROBERTS CO.: *R. Brooks* 438 (KANU).

Equisetum scirpoides Michx. Fl. Bor. Amer. 2:281. 1803.

South Dakota: LAWRENCE CO.: *G. N. Jones* and *F. F. Jones* 14862 (MO).

Equisetum sylvaticum L. Sp. Pl. 2:1061. 1753.

North Dakota: CAVALIER CO.: *O. A. Stevens* and *D. R. Moir* 1767 (NDA). PEMBINA CO.: *R. Brooks* 447 (KANU).

South Dakota: CUSTER CO.: *A. J. Petrik-Ott* 791 (KANU). LAWRENCE CO.: *E. J. Palmer* 37347 (UMO). PENNINGTON CO.: *C. A. Taylor* 8112 (SDC).

Family Isoetaceae

Isoetes butleri Engelm. Bot. Gaz. 3:1. 1878.

Kansas: CHEROKEE CO.: *A. S. Hitchcock* 1068 (KSC).

Isoetes melanopoda Gay et Durieu, Bull. Soc. Bot. France 11:102. 1864.

Kansas: SALINE CO.: *J. C. Hancin* 2447 (KANU). WILSON CO.: *R. L. McGregor* 10267 (KANU).

Nebraska: CLAY CO.: *W. L. Tolstead*, 5 July 1941 (NEB). FILLMORE CO.: *W. L. Tolstead*, 11 July 1941 (NEB). HAMILTON CO.: *W. Kiener* 17851 (NEB). HARLAN CO.: *W. Kiener* 11850 (NEB). KEARNEY CO.: *W. L. Tolstead*, 23 July 1941 (NEB).

South Dakota: MELLETTE CO.: *W. H. Over* 15878 (SDU).

Family Lycopodiaceae

Lycopodium obscurum L. Sp. Pl. 2:1102. 1753.

South Dakota: LAWRENCE CO.: *P. A. Rydberg* 1185 (NEB).

Family Selaginellaceae

Selaginella engelmanii Hieron. Hedwigia 39(5):294. 1900.

Nebraska: HOLT CO.: *W. T. Barker* 2970 (KANU).

North Dakota: BILLINGS CO.: *R. Brooks* 417 (KANU). BOTTINEAU CO.: *O. A. Stevens*, 25 July 1962 (NDA). BURKE CO.: *R. Brooks* 406 (KANU). DUNN CO.: *R. Brooks* 394 (KANU). EDDY CO.: *O. A. Stevens* 2110 (NDA). GOLDEN VALLEY CO.: *H. F. Bergman* 1158 (NDA). GRANT CO.: *Bell* 632 (NDA). MCHENRY CO.: *L. R. Haldron* 2337 (NDA). MCKENZIE CO.: *R. Brooks* 415 (KANU). MOUNTRAIL CO.: *O. A. Stevens* and *D. R. Moir*, 12 July 1960 (NDA). SIOUX CO.: *O. A. Stevens*, 5 Aug. 1965 (NDA). SLOPE CO.: *R. Brooks* 421 (KANU). STARK CO.: *H. F. Bergman*, 21 June 1910 (NDA). WARD CO.: *J. Lunell*, 1 July 1909 (NDA). WILLIAMS CO.: *R. Brooks* 412 (KANU).

South Dakota: CUSTER CO.: *P. A. Rydberg* 1184 (NEB). HARDING CO.: *Over* and *Solem* 11358 (SDU). PENNINGTON CO.: *S. Stephens* 7310 (KANU). PERKINS CO.: *S. Stephens* 8106 (KANU).

Selaginella rupestris (L.) Spring., Flora 21(12):149, 182. 1838.

Kansas: CHAUTAUQUA CO.: *A. J. Petrik-Ott* 739 (KANU). DOUGLAS CO.: *R. L. McGregor* 4663 (KANU). ELK CO.: *R. L. McGregor* 966 (KANU). FRANKLIN CO.: *R. L. McGregor* 1003 (KANU). GREENWOOD CO.: *R. L. McGregor* 3410 (KANU). JOHNSON CO.: *R. L. McGregor* 1004 (KANU). LEAVENWORTH CO.: *R. L. McGregor* 999 (KANU). MONTGOMERY CO.: *R. L. McGregor* 996 (KANU). NEOSHO CO.: *R. L. McGregor* 967 (KANU). WILSON CO.: *R. L. McGregor* 995 (KANU). WOODSON CO.: *A. J. Petrik-Ott* 720 (KANU).

Nebraska: ANTELOPE CO.: *N. F. Petersen,* 7 Aug. 1907 (NEB). BLAINE CO.: *S. Stephens* 24376 and *R. Brooks* (KANU). BOX BUTTE CO.: *C. H. Churchill,* about 1907 (NEB). BROWN CO.: *W. Kiener* 29757 (NEB). CHERRY CO.: *J. M. Bates,* June 1891 (NEB). HOLT CO.: *J. M. Winter,* 28 June 1931 (SDU). KEYA PAHA CO.: *W. Kiener* 23695 (MO). LOUP CO.: *S. Stephens* 6858 (KANU).

North Dakota: PEMBINA CO.: *R. Brooks* 455 (KANU).

South Dakota: CODINGTON CO.: *W. H. Over* 15474 (SDU). CUSTER CO.: *A. J. Petrik-Ott* 788 (KANU). HANSON CO.: *L. J. Harms* 2759 (KANU). MINNEHAHA CO.: *L. J. Harms* 2659 (KANU). PENNINGTON CO.: *S. Stephens* 7104 (KANU). TURNER CO.: *J. H. Martin* 594 (SDU).

DOUBTFUL COLLECTIONS AND EXCLUDED TAXA

Adiantum pedatum: This species was reported by Bessey (1892) for the Black Hills of South Dakota, but discounted by himself in his 1898 and 1900 publications. Rydberg (1917) again reports the presence of *Adiantum pedatum* in the Black Hills, although he states that the section in his manual concerning ferns was contributed by Miss Margaret Slosson. Miss Slosson, at the time of writing the fern section, was situated at the New York Botanical Garden. This leaves the possibility that there is a specimen, at the New York Botanical Garden, which I have not seen.

McIntosh (1949) reports the presence of *Adiantum pedatum* in his work on the Black Hills, but his information is based upon Rydberg (1917), as is Winter, Winter, and Van Bruggen's (1959). Van Bruggen (1967), however, states that there is a specimen of *Adiantum pedatum* that was collected in Lawrence County, on the north slope of Spearfish Mountain by F. L. Bennett in 1941. Brooks (1969) states that this particular station has never been relocated.

I have not seen the Bennett specimen or any other specimens of *Adiantum pedatum* from the Black Hills and, therefore, in my work, exclude it from this region.

Asplenium trichomanes: There is a specimen of *Asplenium trichomanes,* located in the SDU herbarium and originally misidentified as *Cystopteris* sp., from Devil's Lake, Ramsey Co., North Dakota, collected by W. H. Over, 22

June 1908. The herbarium label accompanying this specimen is quite confusing. The locality of collection written on the label is Devil's Lake, but the printed heading on the label reads, "Flora of South Dakota, State Geol. and Biol. Survey Collections, Plants of Clay Co., S.D.". There is no place in South Dakota known as Devil's Lake and therefore, someone later wrote in 'North Dakota' on the label. Devil's Lake is located in Ramsey County, North Dakota, but this record still remains questionable, due to the confusing label information and the lack of a suitable habitat in the area of Devil's Lake to support this species.

Athyrium filix-femina: KANSAS: OSAGE CO.: *C. H. Stokely*, May 1895 (KSC). This specimen was collected in the town of Burlingame, Kansas. I would, however, be hesitant to accept this as a valid record since there is no suitable habitat near Burlingame where this fern might be found. Furthermore, it is commonly found in cultivation and C. H. Stokely is known to have collected many cultivars.

Cryptogramma acrostichoides: NEBRASKA: FRANKLIN CO.: *E. M. Hussong*, 1893 (NEB). The collection locality for this specimen is given as Franklin, Nebraska and no habitat information is given. It consists of only a few fertile segments. *Cryptogramma acrostichoides* is normally found in rocky crevices, on rocky slopes or slides. Such habitats are not to be found near the town of Franklin nor in the county. The closest collection site for this fern is in the Rocky Mountains of Colorado where it is common at altitudes of 7,000 to 12,000 feet. It would be difficult to accept this as a valid record for Franklin County, Nebraska.

Dryopteris goldiana: KANSAS: LEAVENWORTH CO.: *J. Wilson*, 1871 (KANU). This specimen was collected in the town of Leavenworth, Kansas. Mr. Wilson is known to have cultivated ferns and several of his cultivated specimens are on deposit in the KANU herbarium. This specimen does not bear the abbreviation 'cult.' on the label although many of Wilson's other specimens do. McGregor and Hartman (1956) note: "It . . . seems as though the

labels were prepared by someone other than Wilson, for the same handwriting appears on other labels in the herbarium. It seems certain that the individual writing the labels merely omitted the 'cult.' inadvertently . . . , and thus introduced errors in our records." Wilson gives no habitat data or exact locality for his specimen. It is unlikely that there is any natural area near Leavenworth or anywhere in Kansas that would meet the habitat requirements of *Dryopteris goldiana*.

Equisetum variegatum: This species has been erroneously reported many times as occurring in Kansas, Nebraska, South and North Dakota. I saw several specimens identified to this species, but they were all depauperate forms of *Equisetum laevigatum*. On the basis of the specimens I observed, this species is probably best excluded from the list of Equisetums for the four-state area.

Matteuccia struthiopteris: Cragin (1885) reports *Matteuccia struthiopteris* from Lawrence, in Douglas County, Kansas upon the word of Carruth. It is unlikely that it grows any place in Kansas in nature. I have seen it doing quite well in several gardens and greenhouses in Lawrence.

Ophioglossum vulgatum: Gates (1940) reports *Ophioglossum vulgatum* from Douglas County, Kansas upon the basis of a specimen at the University of Kansas. The KANU herbarium has no such specimen. Clausen (1938) cites a specimen collected in Crawford County, Kansas on June 15, 1929 by F. A. Riedel and states that the specimen is on deposit in the herbarium of the New York Botanical Garden. Since I have not seen the specimen mentioned by Clausen (1938), or any duplicates, to check its validity, I am hesitant to include *Ophioglossum vulgatum* for Kansas until further evidence is secured.

Osmunda claytoniana: This species has been erroneously reported from Nebraska by Rydberg (1932).

Polystichum acrostichoides: NEBRASKA: No county given, *L. Bruner*, no date given (NEB). No locality, other

than Nebraska, or date of collection is given for this specimen. It is probably best considered as a doubtful record.

Thelypteris noveboracensis: KANSAS: POTTAWATOMIE CO.: *G. Shimp,* 30 April, no year given (KSC). This specimen was collected near the town of St. George, Kansas. The habitat requirements of *Thelypteris noveboracensis* are not likely to be met in Kansas. Furthermore, Miss Shimp is known to have collected flowering plants from near St. George that are garden plants and its seems possible that this specimen came from a similar habitat.

NEBRASKA: DOUGLAS CO.: *W. Cleburne,* 6 Oct. 1893 (NEB). This specimen was collected in the city of Omaha, Nebraska. In the NEB herbarium is placed, also, a specimen collected on September 20, 1894, by W. Cleburne in a garden in Omaha. It is likely that the 1893 specimen was also collected in a garden and this information not mentioned on the label.

ACKNOWLEDGEMENTS

This checklist has been made possible through the kind cooperation of the curators at the following herbaria: KANU, KSC, KSTC, MO, NEB, NDA, SDC, SDU and UMO, who loaned me innumerable specimens for examination. The accumulation of the data presented here has also been greatly enhanced by financial assistance from the National Science Foundation Graduate Traineeship Program, The University of Kansas Committee on Systematics and Evolutionary Biology (GB-446X, Dr. George W. Byers, Principal Investigator) and the Sigma Xi Committee on Grants-in-Aid of Research. Special thanks are due my husband, Dr. Franklyn D. Ott, for his encouragement throughout the writing of this paper, Mr. and Mrs. Leo J. Petrik, Dr. Ronald L. McGregor, Mr. Ronald Weedon, Mr. Wayne Robuck, Mr. Kermit Johnson, and Miss Mary Wiegand who assisted me with field collecting, Mrs. Martha W. Rhodes for assistance in proof-reading the manuscript, and Mrs. Ann Tyska who typed the final manuscript.

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SEASONAL OCCURRENCE AND ECOLOGY OF MARINE ALGAE IN A NEW HAMPSHIRE TIDAL RAPID[1]

NORMAN B. REYNOLDS[2] AND
ARTHUR C. MATHIESON

Water motion is a major factor determining the growth and abundance of benthic plants in the ocean since it enhances their metabolism (Conover, 1968) and assists in the propagation of plants and their dispersal to new areas. Several workers (see Lewis, 1964) have discussed the effects of wave action on the species composition and distribution of seaweeds. Exposed coastal sites typically have more productive and diverse algal populations than sheltered locations, presumably because of differential water motion. Sheltered embayments with strong tidal currents are also rich, productive habitats (Lewis, 1968; Schwenke, 1971). To date, few detailed studies have been conducted of tidal rapid communities except for the comprehensive biological-hydrographical studies at Lough Ine, Ireland (Kitching and Ebling, 1967). In the present paper we describe the seasonal occurrence and ecology of seaweeds at the Dover Point, New Hampshire tidal rapid.

The tidal rapid at Dover Point, New Hampshire, has several unique features which distinguish it from other tidal rapids. Foremost, it is located in the middle of the Great Bay Estuary System, rather than near the open coast (Fig. 1). Secondly, its substrate is stable even though it is partially composed of small pebbles and cobbles. Thirdly, it has one of the fastest currents on the east coast of North America (Anon., 1969).

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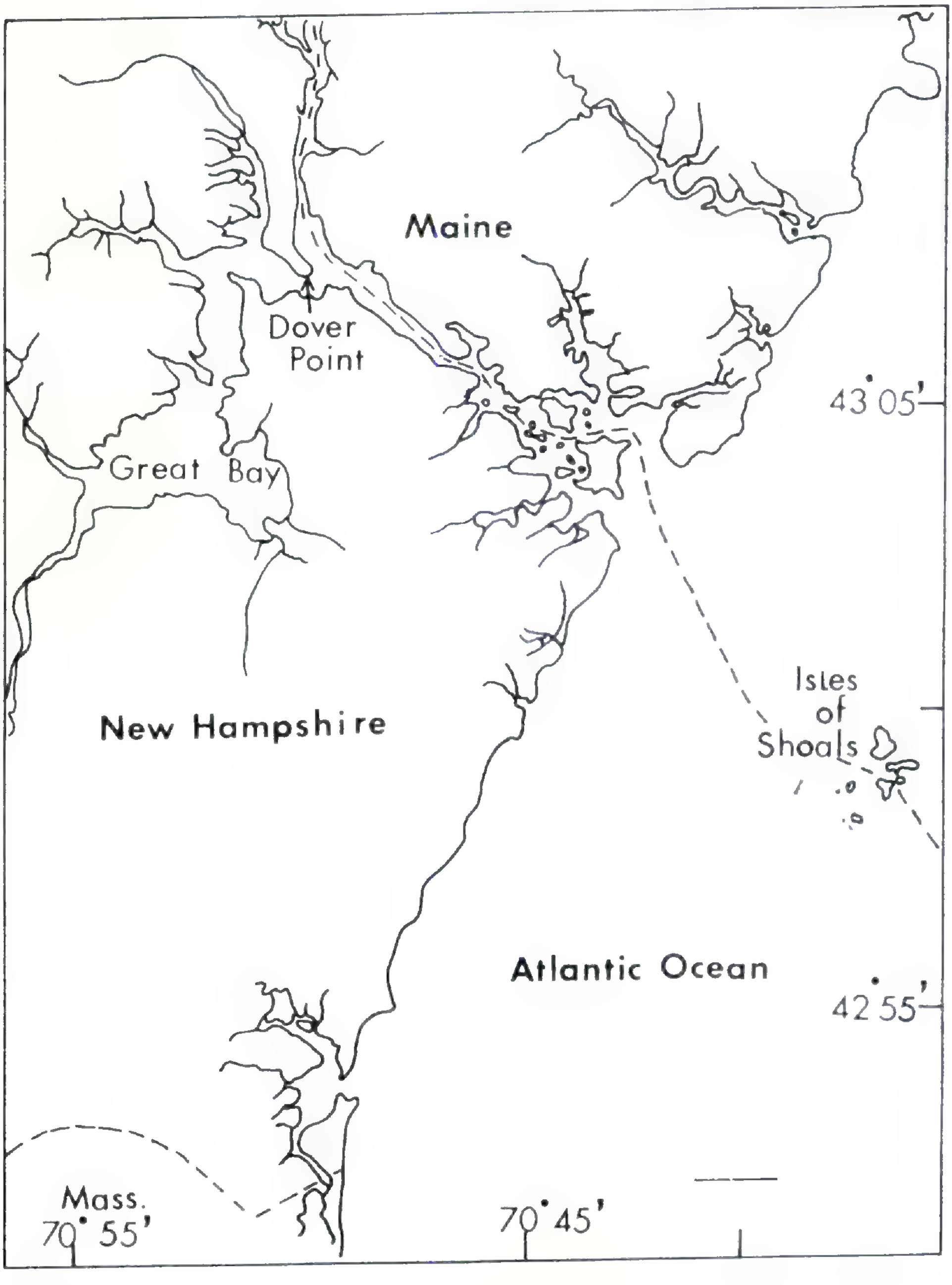

Fig. 1. The New Hampshire Coast and the Great Bay Estuary System.

MATERIALS AND METHODS

Monthly collections of seaweeds were made during low tides from September, 1967, to September, 1969. Seasonal collections of sublittoral plants were made (by SCUBA) during 1968. Diving was only possible for about 20 minutes at dead low tide; it was further restricted by the severe winter weather. No drift specimens are reported. All specimens were processed immediately after collection. Herbarium voucher specimens (a total of 1,264) were deposited in the Algal Herbarium of the University of New Hampshire (NHA). The specimens were identified according to Taylor (1957), with the exception of *Fucus* (Powell, 1957a, 1957b, 1963), *Porphyra* (Conway, 1964a, 1964b), and *Laminaria* (Wilce, 1965). The revised nomenclature of Parke and Dixon (1968) was applied whenever possible. The longevity of the plants was designated according to Feldman's (1951) terminology.

General weather conditions (rainfall, air temperatures and occurrence of ice) were recorded during field observa-

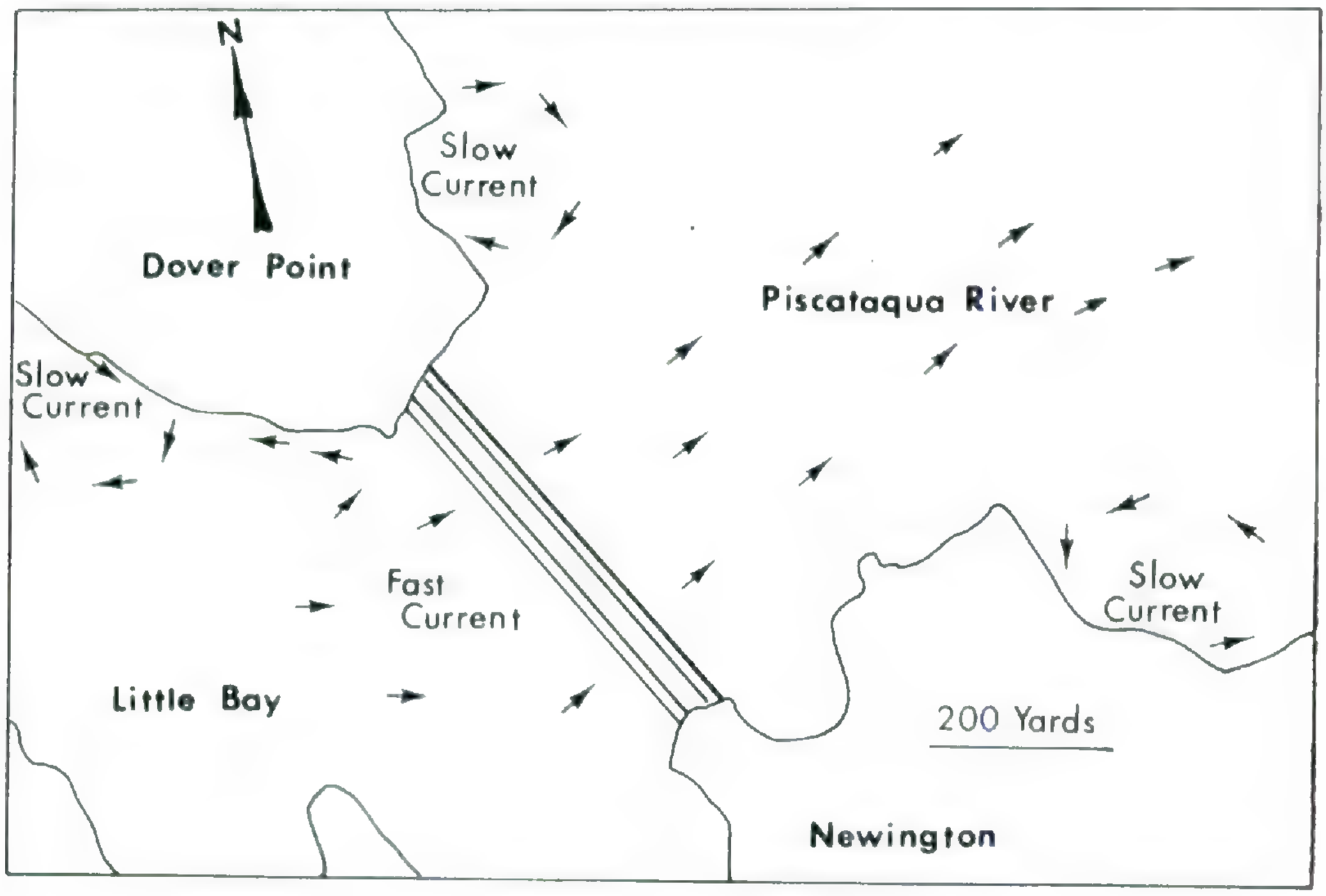

Fig. 2. Dover Point and surrounding areas.

tions. Biweekly records of surface water temperatures, salinities and dissolved oxygen concentrations were monitored at dead low tide in the high and low current areas at Dover Point (Fig. 2). Salinities were recorded in the field with a set of hydrometers (G. M. Mfg. Co., New York); all of the values were corrected to 15°C. Temperatures were recorded with a common immersible thermometer. Oxygen concentrations were determined by use of a modified Winkler method (Hach Chem. Co., Ames, Iowa). Diurnal variations of temperature, salinity, oxygen concentration and current speed were recorded on five separate occasions. Salinities and temperatures were recorded at multiple depths with an Electrodeless Induction Salinometer (G. M. Mfg. Co., New York). The current speed was recorded with a Little Captain boat speedometer (Swift Instrument Company of Boston, Massachusetts), which was modified with a six-foot well tube. The accuracy of the instruments is ± ¼ knots.

DESCRIPTION OF AREA AND ENVIRONMENTAL FACTORS

Dover Point is located at latitude 47°07′05″ N. and longitude 70°49′50″ W. in Dover, New Hampshire (Fig. 1). It is 5 miles northwest of Portsmouth, New Hampshire, and 5 miles east southeast of Durham, New Hampshire, at the junction of the Piscataqua River and Little Bay. All of the waters entering and leaving Little Bay, Great Bay and their five tributaries pass through the constricted channel at Dover Point, which is 470 yards wide and has a maximum depth of 34 feet.

The rock outcroppings at Dover Point are of the Eliot formation (Novotny, 1968). A variety of substrate types are present; they grade from boulders to cobbles, pebbles, sand and mud. The rocks are composed of mica schist with garnet crystals, phyllite, pegmatite-quarts, feldspar and metasiltstone. Smaller rocks and pebbles are stabilized by extensive mussel populations, which allow them to support relatively large plants. Most of the collections were ob-

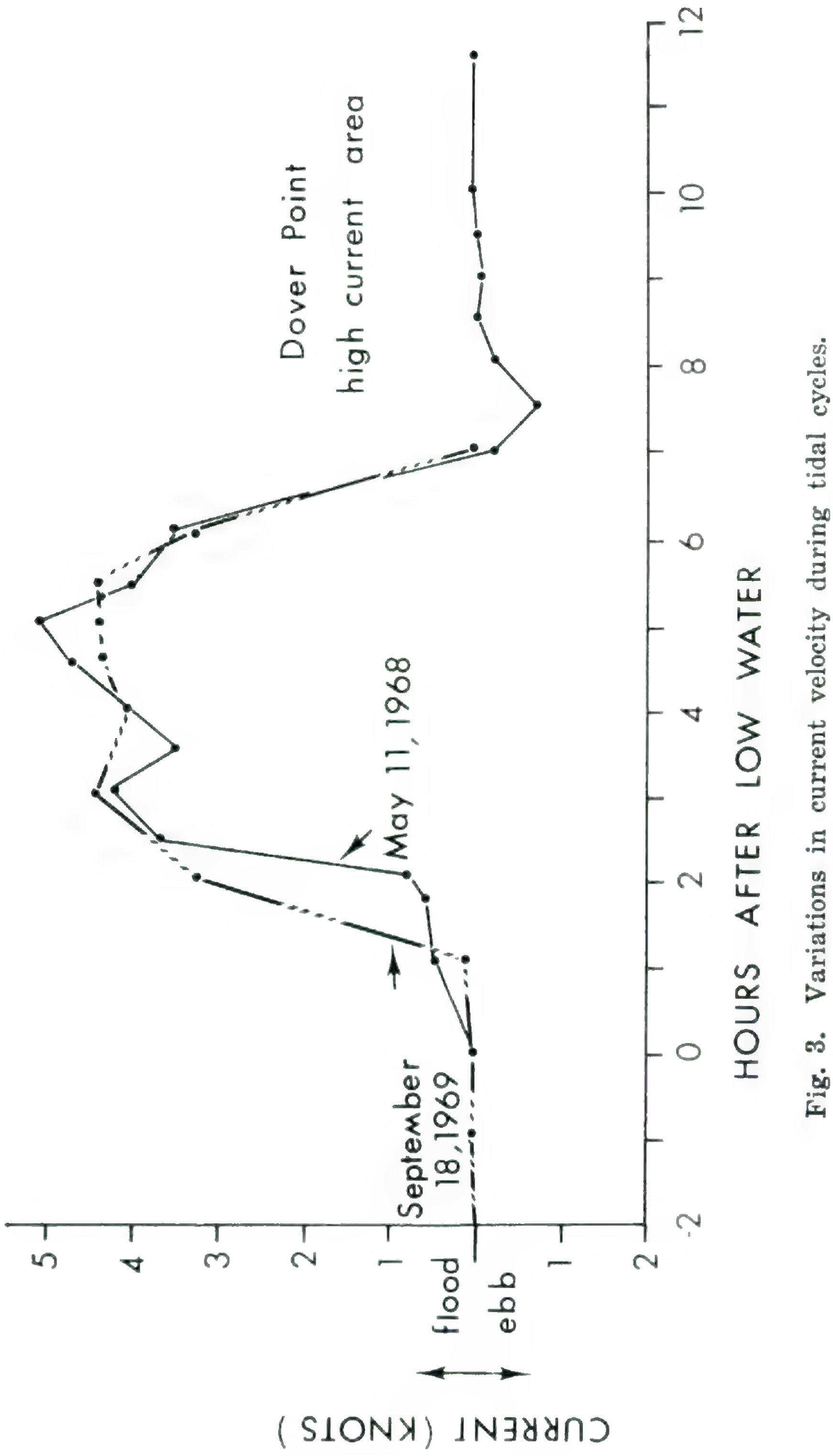

Fig. 3. Variations in current velocity during tidal cycles.

tained in the areas of high currents under the bridge (Fig. 2). The locations to the northeast and southwest of the bridge are mud flats which have reduced currents. The substrate in the high current area grades from rock near shore into mud at approximately 20 feet below mean low water.

The tides at Dover Point are semi-diurnal, and they occur 87 minutes later than those of the adjacent open coast (Anon., 1965). The tidal amplitude is 6.8 feet. A maximum tidal current of 5.5 knots occurs 2.5 to 5 hours after low tide (Fig. 3). During ebb tide the current is concentrated on the Newington side of the channel; it is accompanied by a slight back eddy on the Dover Point side. Organisms in the lower intertidal and subtidal zones are exposed to strong currents at least 50% of the time (flood tide), while organisms in the upper intertidal zone are rarely exposed to strong currents. Subtidal organisms beyond the second piling (Fig. 2) are exposed to a nearly continuous current of high intensity.

The annual range of water temperatures was −2.0° to 19.0°C (Fig. 4). Diurnal temperature fluctuations at Dover Point depend on the two water masses involved—i.e., Great Bay and the Atlantic Ocean. Little or no diurnal variation (0-0.5°C) occurred during the winter. The largest diurnal variation (5°C) occurred during the late spring and summer. The annual range of salinity at Dover Point was 7.5 o/oo at spring runoff to 31.0 o/oo in the late summer (Fig. 4). It usually varied from 23-29 o/oo. The greatest diurnal fluctuation of salinity was recorded during March, 1969 (i.e., 10 o/oo). In general there was a decrease in salinity from low tide until one hour after the predicted low. Thereafter it rose until high tide at which time it decreased for two to three hours. The dissolved oxygen concentration varied seasonally, with peak values occurring in the spring (12-14 ppm) and minimal values in the late summer (6-8 ppm). No obvious differences in temperature, salinity and oxygen values were found between the high and low current areas.

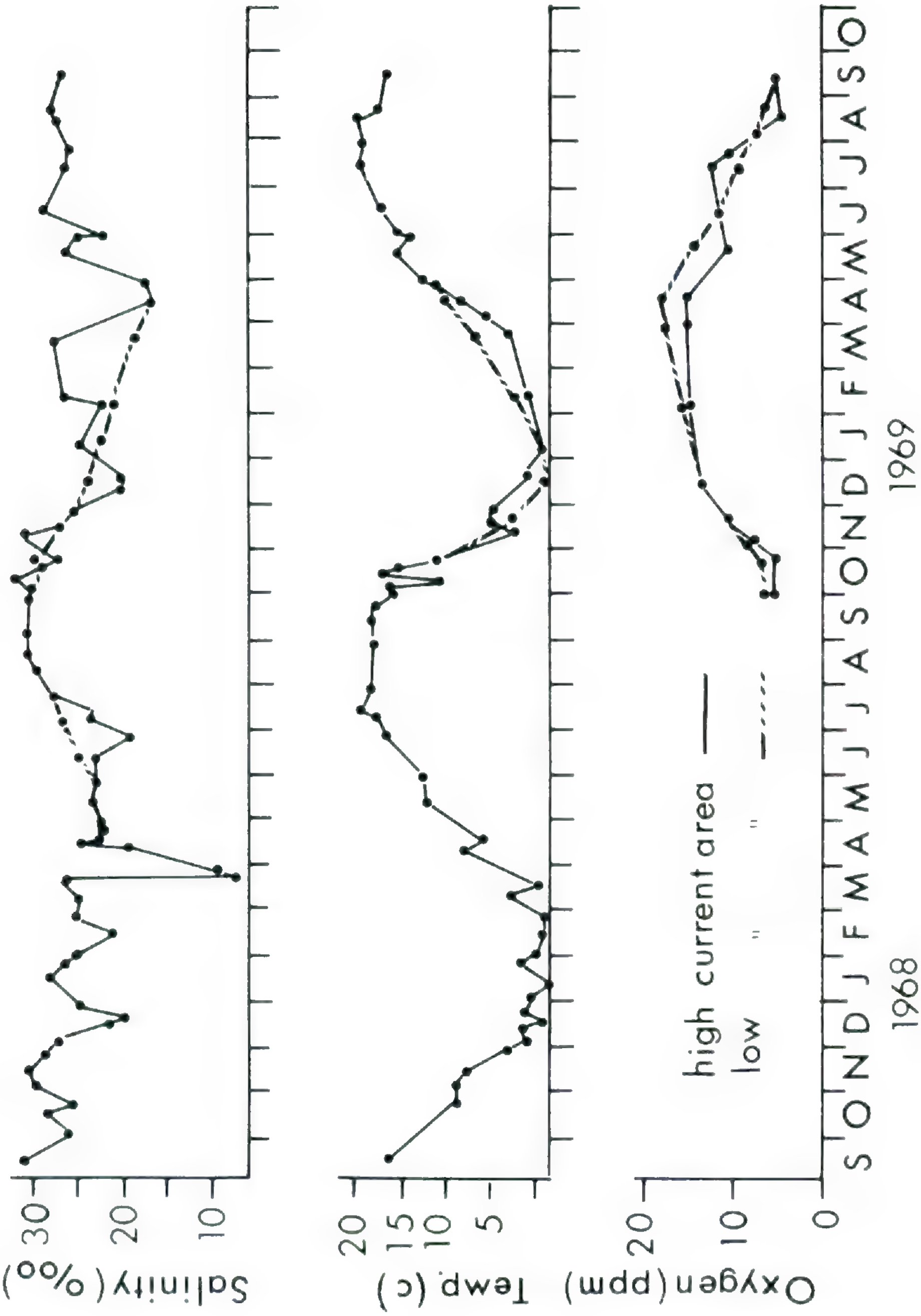

Fig. 4. Seasonal temperature, salinity and oxygen variations.

SPECIES COMPOSITION

The algal flora at Dover Point shows a high diversity of species for an estuarine habitat. Eighty-three taxa of seaweeds were recorded from the tidal rapid site at Dover Point, including 39 Rhodophyceae, 24 Chlorophyceae and 20 Phaeophyceae. Table I summarizes the number and kind of seaweeds encountered at Dover Point as well as at adjacent coastal and estuarine locations. Seventy-one of the taxa found at Dover Point were also found on the adjacent open coast (Mathieson & Fralick, 1972; Maithieson, Hehre & Reynolds, in press). In contrast, only 59 taxa from Dover Point were found in adjacent estuarine sites with calm waters (Mathieson, Reynolds & Hehre, in press). The red and brown algae at Dover Point showed more affinities to the open coast than the green algae (Table I).

SEASONAL OCCURRENCE

Tables II-IV summarize the monthly occurrence and longevity of each species based on three years of monthly collections at Dover Point. The maximum number of species of Rhydophyceae were found in July (Table V). Peak numbers of Chlorophyceae were evident in May, while the Phaeophyceae showed peaks in April and May (Table V). Table V also records the total number of seaweeds collected per month; the largest number of species occurred during May to July. The low numbers recorded in January and September resulted from a lack of subtidal collections.

Several taxa were rare at Dover Point. *Bryopsis plumosa*, *Enteromorpha compressa*, *Monostroma leptodermum*, *Ascophyllum nodosum* forma *scorpioides*, *Fucus distichus* spp. *evanenscens*, *Myrionema strangulans*, *Sphacelaria cirrosa*, *Ceramium strictum*, *Dermatolithon pustulatum*, *Gloiosiphonia capillaris*, *Melobesia lejolisii* and *Rhodochorton purpureum* were only found once during the entire three year period. Of particular interest was the sporadic occurrence of *Gloiosiphonia capillaris*, for it was only seen during a two week period and it was represented by 10 plants within a 10 ft^2 area. A comparison of Tables II-IV

shows that six of the above species are annuals, which might be expected to have a sporadic distribution. Other seaweeds such as *Callithamnion baileyi, Dasya pedicellata, Lomentaria orcadensis, Polysiphonia harveyi, P. lanosa* and *Laminaria longicruris* were collected twice during the 36 month study. *Monostroma pulchrum, Gracilaria foliifera, Porphyra miniata* and *Chordaria flagelliformis* were collected three times. *Laminaria longicruris, Gracilaria foliifera* and *Polysiphonia lanosa* are perennials, while all the others are annuals (Tables III and IV).

Forty-two of the 83 taxa collected at Dover Point were considered to be perennials (Table VI). Most of the green algae were annuals (79%). A larger portion of the brown (65%) and red algae (62%) were perennials. Two distinct types of annuals are present at Dover Point: seasonal and aseasonal. Seasonal annuals occur during a certain season and subsequently disappear. *Monostroma grevillei, Spongomorpha arcta, Bangia fuscopurpurea,* and *Urospora penicilliformis* are examples of late winter and/or spring annuals. *Chorda tomentosa, Bryopsis plumosa, Antithamnion cruciatum, Callithamnion baileyi, Ceramium strictum* and *Dasya pedicellata* are summer annuals. Aseasonal annuals, such as *Ectocarpus confervoides, Petalonic fascia, Scytospihon lomentaria, Enteromorpha intestinalis* and *Ulothrix flacca* occur all year long, although they may have peaks in the spring and summer. Aseasonal annuals are represented by several generations of plants.

Two major types of perennial algae are also evident at Dover Point. *Ascophyllum nodosum, Fucus vesiculosus, Laminaria* spp., *Pseudendoclonium marinum, Ahnfeltia plicata, Chondrus crispus, Gigartina stellata, Phyllophora membranifolia* and *Rhodymenia palmata* are typical of the most common type where the whole plant is perennial. Other species such as *Elachista fucicola, Pilaiella littoralis, Cladophora sericeae* and *Phycodrys rubens* perenniate by a portion of the thallus. Transitional forms are also evident between the two types. Knight and Parke (1931) designate plants as pseudperennials if a small persistent portion of the thallus can regenerate the intact plant.

DISCUSSION

The algal flora at Dover Point is "open coastal" in character for it has a very productive and diverse flora, as well as a large number of species in common with the open coast. It should be emphasized that adjacent, estuarine areas, that lack currents but have similar substrate and hydrographic conditions support a less diverse and reduced vegetation. Lewis (1964) reports a similar biological characterization of tidal rapids in Scotland and Ireland. In addition he records the "dying out" of more delicate algae in favor of more robust forms with increased water flow.

Kitching and Ebling (1967) state that the major influence of tidal currents is exerted on the sublittoral zone. They also suggest that tidal currents are analogous to wave action, for they prevent the deposition of sediment, reduce local extremes of temperature and oxygen, and exert strong mechanical pull. Moore (1966) states that tidal rapids support open coastal invertebrates, even though the locations are essentially sheltered. The sublittoral zone at Dover Point has more "open coastal" species than the littoral zone.

Pronounced seasonal fluctuations of algal species were recorded at Dover Point, with the largest number of species occurring in July and the lowest in the winter. The wide range of hydrographic conditions, particularly temperature, probably causes the seasonal differences in its flora. Williams (1948, 1949) and Coleman and Mathieson (1975) have also recorded a wide range of annuals in areas with pronounced temperature fluctuations. A combination of boreal (e.g., *Dumontia incrassata*, *Porphyra umbilicalis*) and warm temperate annuals (e.g., *Callithamnion baileyi*, *Dasya pedicellata*) are present in the Great Bay Estuary System, because of the wide range of temperatures (Mathieson, Reynolds and Hehre, in press). The seasonal occurrence of organisms at Dover Point is very similar to that at the adjacent open coast near Portsmouth, New Hampshire (Mathieson, Hehre & Reynolds, in press), except that a larger number of spring annuals is evident during April on the open coast.

TABLE I. SPECIES COMPOSITION AT DOVER POINT AND ADJACENT LOCATIONS

Rhodophyceae

TAXON	Dover Point Tidal Rapid	Open Coast	Estuarine nontidal rapid
Ahnfeltia plicata (Huds.) Fries	X	X	X
Antithamnion cruciatum (C. Ag.) Nageli	X	X	
Audouinella membranacea (Magn.) Papenfuss	X	X	X
Bangia fuscopurpurea (Dillw.) Lyngb.	X	X	X
Callithamnion baileyi Harvey	X	X	X
Callithamnion corymbosum (Smith) Lyngb.	X		
Ceramium rubrum (Huds.) J. Ag.	X	X	X
Ceramium strictum Harvey	X		X
Chrondrus crispus Stackhouse	X	X	X
Clathromorphum circumscriptum (Stromf.) Foslie	X	X	
Cystoclonium purpureum (Huds.) Batters var. *cirrhosum* Harvey	X	X	X
Dasya pedicellata (C. Ag.) C. Ag.	X		X
Dermatholithon pustulatum (Lamouroux) Foslie	X	X	
Dumontia incrassata (Mull.) Lamouroux	X	X	X
Gigartina stellata (Stackhouse) Batt.	X	X	X
Gloiosiphonia capillaris (Huds.) Carm. *ex* Berkley	X	X	
Gracilaria foliifera (Forsskal) Borgesen	X		X
Hildenbrandia prototypus Nardo	X	X	X
Kylinia secundata (Lyngb.) Papenfuss	X	X	X
Lomentaria orcadensis (Harvey) Collins	X	X	

TABLE I. — Rhodophyceae (continued)

Taxon	Dover Point Tidal Rapid	Open Coast	Estuarine non tidal rapid
Melobesia lejolisii Rosan.	X	X	X
Petrocelis middendorfii (Ruprecht) Kjell.	X	X	
Phycodrys rubens (L.) Batt.	X	X	
Phyllophora membranifolia (Good. *et* Woodw.) J. Ag.	X	X	
Phymatolithon lennormandi (Aresch.) Adey	X	X	
Polyides rotundus (Huds.) Grev.	X	X	
Polysiphonia dendata (Dillw.) Grev. *ex* Harv. in Hook.	X		X
Polysiphonia elontata (Huds.) Grev. *ex* Harv. in Hook.	X		X
Polysiphonia harveyi Bailey	X		X
Polysiphonia lanosa (L.) Tandy	X	X	
Polysiphonia nigra (Huds.) Batt.	X	X	X
Polysiphonia nigrescens (Huds.) Grev.	X	X	X
Polysiphonia novae-angliae Taylor	X	X	X
Polysiphonia urceolata (Lightfoot *ex* Dillw.) Grev.	X	X	
Porphyra leucosticta Thur. in Le Jol. sensu Conway	X	X	
Porphyra miniata (C. Ag.) C. Ag. sensu Conway	X	X	X
Porphyra umbilicalis (L.) J. Ag. sensu Conway	X	X	X
Rhodochorton purpureum (Lightfoot) Rosenvinge	X	X	
Rhodymenia palmata (L.) Grev.	X	X	
Subtotal	39	32	23
% of subtotal	100%	82%	58%

TABLE I. — (continued)

Phaeophyceae

Taxon	Dover Point Tidal Rapid	Open Coast	Estuarine non tidal rapid
Ascophyllum nodosum (L.) Le Jolis	X	X	X
Ascophyllum nodosum (L.) Le Jolis f. *scorpioides* (Hornemann) Reinke	X		X
Chorda tomentosa Lyngb.	X	X	
Chordaria flagelliformis (Mull.) C. Ag.	X	X	
Ectocarpus confervoides (Roth) Le Jolis	X	X	X
Elachista fuciocola (Velley) Areschoug	X	X	
Fucus distichus (L.) emend. Powell spp. *edentatus* (De la Pylaie) Powell	X	X	X
Fucus distichus (L.) emend. Powell spp. *evanescens* (C. Ag.) Powell	X	X	X
Fucus vesiculosus L.	X	X	X
Fucus vesiculosus L. var. *spiralis* Farlow	X		X
Griffordia granulosa (J. E. Smith) Hamel	X		X
Laminaria digitata (Huds.) Lamouroux	X	X	
Laminaria longicruris de la Pylaie	X	X	
Laminaria saccharina (L.) Lamour. sensu Wilce	X	X	X
Myrionema strangulans Grev.	X	X	
Petalonia fascia (O. F. Müll.) Kuntze	X	X	X
Pilayella littoralis (L.) Kjell.	X	X	X
Ralfsia verrucosa (Aresch.) J. Ag.	X	X	X

TABLE I. — PHAEOPHYCEAE (continued)

Taxon	Dover Point Tidal Rapid	Open Coast	Estuarine non tidal rapid
Scytosiphon lomentaria (Lyngb.) Link	X	X	X
Sphacelaria cirrosa (Roth) C. Ag.	X	X	X
Subtotal	20	17	14
% of subtotal	100%	85%	70%

Chlorophyceae

Taxon			
Blidingia minima (Nag. *ex* Kutz.) Kylin	X	X	X
Bryopsis plumosa (Huds.) C. Ag.	X		X
Chaetomorpha linum (Müll.) Kütz.	X	X	X
Chaetomorpha melagonium (Web. *et* Mohr) Kutz.	X	X	
Cladophora sericeae (Huds.) Kutz. sensu van den Hoek	X	X	X
Enteromorpha compressa (L.) Grev.	X	X	X
Enteromorpha erecta (Lyngb.) J. Ag.	X	X	X
Enteromorpha intestinalis (L.) Link	X	X	X
Enteromorpha linza (L.) J. Ag.	X	X	X
Enteromorpha prolifera (Müll.) J. Ag.	X	X	X
Monostroma fuscum (Post. *et* Rupr.) Wittr.	X	X	X
Monostroma grevillei (Thuret) Wittr.	X	X	X
Monostroma leptodermum Kjell.	X	X	X

TABLE I. — CHLOROPHYCEAE (continued)

TAXON	Dover Point Tidal Rapid	Open Coast	Estuarine non tidal rapid
Monostroma oxyspermum (Kütz.) Doty	X		X
Monostroma pulchrum Farlow	X	X	X
Percursaria percursa (C. Ag.) Rosenvinge	X	X	X
Pseudendoclonium marinum (Rein.) Aleem *et* Schulz	X	X	X
Rhizoclonium riparium (Roth) Harvey var. *implexum* (Dillw.) Rosenvinge	X	X	X
Rhizoclonium tortuosum Kütz.	X	X	X
Spongomorpha arcta (Dillw.) Kütz.	X	X	
Ulothrix flacca (Dillw.) Thur. in Le Jol.	X	X	X
Ulva lactuca L.	X	X	X
Urospora collabens (C. Ag.) Holmes *et* Batt.	X	X	X
Urospora penicilliformis (Roth) Aresch.	X	X	X
Subtotal	24	22	22
% of subtotal	100%	91%	91%

TABLE II. SEASONAL OCCURRENCE AND LONGEVITY OF CHLOROPHYCEAE

Taxon	Months												Longevity*
	J	F	M	A	M	J	J	A	S	O	N	D	
Blidingia minima	X								X	X	X	X	A
Bryopsis plumosa							X						A
Chaetomorpha linum	X	X	X	X	X	X	X	X	X	X	X	X	P
Chaetomorpha melagonium						X	X	X	X	X			P
Cladophora sericeae	X	X	X		X	X	X	X	X	X	X	X	PP
Enteromorpha compressa										X			A
Enteromorpha erecta				X		X	X	X	X			X	A
Enteromorpha intestinalis	X	X	X	X	X	X	X	X	X	X	X	X	A
Enteromorpha linza					X	X	X	X	X	X			A
Enteromorpha prolifera							X		X	X			A
Monstroma fuscum	X		X	X	X	X	X	X				X	A
Monostroma grevillei	X	X	X	X	X						X	X	A
Monostroma leptodermum											X		A
Monostroma oxyspermum		X			X							X	A
Monostroma pulchrum					X						X		A
Percursaria percursa		X		X	X	X				X		X	A or PP
Pseudendoclonium marinum	X	X	X	X	X	X	X	X	X	X	X	X	P
Rhizoclonium riparium var. *implexum*								X		X	X		A
Rhizoclonium tortuosum			X	X	X	X							A
Spongomorpha arcta	X	X	X	X	X				X				A or PP
Ulothrix flacca	X	X	X	X	X	X	X	X	X	X	X	X	A
Ulva lactuca		X	X	X	X		X	X	X	X	X	X	A or PP
Urospora collabens		X	X	X	X	X	X						A
Urospora penicilliformis			X	X						X			A

*A = Annual P = Perennial PP = Pseudoperennial

TABLE III. SEASONAL OCCURRENCE AND LONGEVITY OF PHAEOPHYCEAE

	Months												
TAXON	J	F	M	A	M	J	J	A	S	O	N	D	Longevity*
Ascophyllum nodosum	X	X	X	X	X	X	X	X	X	X	X	X	P
Ascophyllum nodosum f. *scorpioides*				X									P
Chorda tomentosa				X	X	X							A
Chordaria flagelliformis					X		X						A
Ectocarpus confervoides	X	X	X	X	X	X	X	X	X	X		X	A
Elachista fuciocola					X	X		X	X	X		X	P
Fucus distichus spp. *edentatus*	X	X	X	X		X	X	X	X	X	X	X	P
Fucus distichus spp. *evanescens*	X	X	X	X	X	X	X	X	X	X	X	X	P
Fucus vesiculosus	X	X	X	X	X	X	X	X	X	X	X	X	P
Fucus vesiculosus var. *spiralis*			X	X	X	X	X		X		X		P
Giffordia granulosa		X	X	X						X	X	X	A
Laminaria digitata	X	X	X	X	X	X	X	X	X	X	X	X	P
Laminaria longicruris		X			X								P
Laminaria saccharina	X	X	X	X	X	X	X	X	X	X	X	X	P
Myrionema strangulans		X											A
Petalonia fascia	X	X	X	X	X	X	X	X	X	X		X	A
Pilayella littoralis			X	X	X	X	X	X		X	X	X	P
Ralfsia verrucosa	X	X	X	X	X	X	X	X	X	X	X	X	P
Scytosiphon lomentaria	X	X	X	X	X	X	X		X	X	X	X	A
Sphacelaria cirrosa				X									P

*A = Annual P = Perennial

TABLE IV. SEASONAL OCCURRENCE AND LONGEVITY OF RHODOPHYCEAE

Taxon	Months												Longevity*
	J	F	M	A	M	J	J	A	S	O	N	D	
Ahnfeltia plicata	X	X	X	X	X	X	X	X	X	X	X	X	P
Antithamnion cruciatum						X	X	X		X			A
Audouinella membranacea						X	X		X			X	P
Bangia fuscopurpurea	X	X	X	X	X	X					X	X	A
Callithamnion baileyi							X						A
Callithamnion corymbosum	X	X	X	X	X	X	X	X			X	X	A
Ceramium rubrum	X		X	X	X	X	X	X	X	X	X	X	P
Ceramium strictum							X						A
Chondrus crispus	X	X	X	X	X	X	X	X	X	X	X	X	P
Clathromorphum circumscriptum	X	X	X	X	X	X	X	X	X	X	X	X	P
Cystoclonium purpureum var. *cirrhosum*	X	X	X	X	X	X	X	X	X	X	X	X	P
Dasya pedicellata							X						A
Dermatholithon pustulatum		X											P
Dumontia incrassata	X	X	X	X	X	X	X		X	X	X	X	A
Gigartina stellata	X	X	X	X	X	X	X	X	X	X	X	X	P
Gloiosiphonia capillaris							X						A
Gracilaria foliifera					X	X		X					P
Hildenbrandia prototypus	X	X	X	X	X	X	X	X	X	X	X	X	P
Kylinia secundata	X		X		X	X			X	X	X	X	P
Lomentaria orcadensis								X		X			A

*A = Annual P = Perennial

TABLE IV. — (continued)

Taxon	Months												Longevity*
	J	F	M	A	M	J	J	A	S	O	N	D	
Melobesia lejolisii					X								P
Petrocelis middendorfii					X		X						P
Phycodrys rubens	X		X	X	X	X	X						P
Phyllophora membranifolia		X	X		X	X		X		X			P
Phymatolithon lennormandi										X			P
Polyides rotundus	X	X	X	X	X	X				X			P
Polysiphonia denuda							X	X			X		A
Polysiphonia elongata	X	X	X	X	X	X	X	X	X	X	X	X	P
Polysiphonia harveyi											X	X	A
Polysiphonia lanosa								X		X			P
Polysiphonia nigra	X	X				X	X	X			X	X	A
Polysiphonia nigrescens	X	X	X	X	X	X	X	X	X	X	X	X	P
Polysiphonia novae-angliae	X	X	X	X	X		X	X	X	X	X	X	P
Polysiphonia urceolata													
Porphyra leucosticta	X	X	X	X	X	X					X	X	A
Porphyra miniata			X		X			X					A
Porphyra umbilicalis	X	X	X	X	X	X	X	X	X	X	X	X	A
Rhodochorton purpureum							X						P
Rhodymenia palmata	X	X	X	X	X	X	X	X	X	X	X	X	P

*A = Annual P = Perennial

TABLE V.

NUMBERS OF TAXA OF RHODOPHYCEAE, PHAEOPHYCEAE, AND CHLOROPHYCEAE COLLECTED AT DOVER POINT DURING VARIOUS MONTHS, 1967-1969

	J	F	M	A	M	J	J	A	S	O	N	D
Rhodophyceae	19	19	21	19	25	24	27	22	15	21	20	21
Phaeophyceae	10	13	13	16	15	14	13	11	11	13	11	12
Chlorophyceae	9	11	12	13	15	12	13	11	12	14	11	12
Total	38*	43	46	48	55	50	53	44	38*	48	42	45

*No subtidal collections were made

TABLE VI.

NUMBERS OF PERENNIAL RHODOPHYCEAE, PHAEOPHYCEAE AND CHLOROPHYCEAE AT DOVER POINT, 1967-1969

	Number of taxa potentially perennial	Total Number of taxa	% of total taxa which were perennial	% of perennial taxa/class
Rhodophyceae	24	39	29	62
Phaeophyceae	13	20	16	65
Chlorophyceae	5(7)	24	6(8)	21(29)
Grand Total	42(44)	83	61(64)	49(52)

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BOOK REVIEW: THE FLORA OF ESSEX COUNTY, MASSACHUSETTS[1]

JAMES P. POOLE

In 1880 a *Flora of Essex County, Massachusetts* was published by John Robinson who had been in charge of the herbarium of the Peabody Museum in Salem, Massachusetts for a number of years, eventually becoming Director of the Museum. His flora consisted of a list of the species then growing or reported to be growing in the County, often with the names of the collectors but with only scant information concerning the habit or habitat or the localities where the species were found. The genera were listed under families that were referred to as "orders" in the summary, following the fifth edition of *Gray's Manual of Botany*. That publication, in turn, followed DeCandolle as modified by Bentham and Hooker's *Genera Plantarum*. In addition to the vascular plants, listed as Exogens, the flora also included mosses, liverworts, lichens, and algae; the fungi were covered by only a brief reference.

In 1951 Stuart Harris, then Professor of Biology at Boston University, acceded to a request to write a modern flora of the County for publication by the Peabody Museum. From that date on he devoted what time he could spare from his teaching duties and other varied interests to intensive study in the field and in some of the herbaria in which early collections from Essex County had been deposited. After many years he completed the Catalog of the Flora and some of the accompanying sections, but unfortunately did not live to complete a preface or write some of the introductory sections he had planned. These portions have been supplied by others. Dorothy Eastman Snyder,

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[1]*The Flora of Essex County, Massachusetts* by Stuart Kimball Harris. Peabody Museum, Salem, Massachusetts. 1975. vii + 269 pp. Map of the County on the inside cover. Sketch of Sweet Bay flower on title page. $12.50

Consultant in Natural History at Peabody Museum, with Stuart Harris, authored the preface and also served as Editor. Other sections included: a Foreword by Richard Jefferson Eaton, former Curator of the herbarium of the New England Botanical Club, who also contributed a brief biographical sketch of the author; one on Geology in Relation to the Flora by Sarah Fraser Robbins, Director of Education at the Museum; another by Robert Lincoln Goodale, M.D., entitled History of Botanical Collecting, with biographical information about some of the collectors of Robinson's time and earlier; and a short section on Climate by Hurd C. Willett, Professor Emeritus of the Department of Meteorology, M.I.T. An End Map was drawn by Charles F. Allen II, Assistant at the Museum. The sections contributed by Dr. Harris included: a Catalog of Species; a Statistical Summary of genera, species, varieties, forms, and hybrids listed by families with each group of taxa designated as Native or Introduced; a list of Species Exclusae; and a list of collectors named in the Catalog with information as to the period and area of activity of each of them. A list of references is also included.

In the Catalog the arrangement of the families and the nomenclature follow *Gray's Manual*, 8th edition, 1950, with few exceptions, but the specific epithets are in lower case as recommended in the *International Code of Botanical Nomenclature*, 1972. Under the genera the species are listed with both Latin and common names, with a brief statement as to habitat and frequency, followed by the names of towns or cities where collected, the names of the collectors, with collectors' numbers and date of collection when available. For the varieties, forms and hybrids, only the locality where collected, the collectors, collectors' numbers, and dates are given, except that information as to habitat and frequency is included for hybrid species. Preceding the Catalog is a list of towns and cities numbered in the order quoted in the Catalog. These numbers are spotted on the End Map.

In the text there are a few misstatements and typographic errors, and in the Catalog there are a number of errors, mostly typographic. In the list of references and also in the section listing the publications by the author there are numerous mistakes, mostly in the year or the volume number of the publication cited. In addition there are some discrepancies which should be recorded. A few of the species included in the Species Exclusae are also listed in the Catalog. It seems probable that Dr. Harris may have decided that some of the questionable species should be included in the Catalog but failed to find the time later to delete the names from the Species Exclusae. Again, if the Statistical Summary is checked against the Catalog, it will be discovered that there are instances in which the two do not agree. Any corrections in the Statistical Summary must affect the Total Summary by Minor Groups on page 23. Thus it is impossible to make any exact comparison in totals with Robinson's Flora. In Harris's Flora the figure given for the Grand Total Taxa (1767) is the same number as that given for the total species. It is evident that it fails to include the totals for varieties, forms, and hybrids.

These discrepancies and errors are difficult to explain but, knowing the competence of Stuart Harris and his scholarly standards, it seems most probable that the inconsistencies and most of the other errors would have been remedied if he could have lived to make that final check that is so essential before any manuscript goes to the printer.

Fortunately, none of these difficulties or errors are of enough significance to detract from the interest or value of this publication. The catalog of species constitutes an authoritative checklist of the flora of the County and, as emphasized in the Foreword (p. vii), Essex County is noteworthy from a phytogeographical point of view. It is an area where Canadian zone species overlap traces of a southern flora, where the northern *Habenaria blephariglottis* grows in the shelter of an indigenous colony of

Magnolia virginiana, Moosewood (*Acer pensylvanicum*) occurs rather abundantly within a few rods of the sea-cliffs at Manchester, and Hobble-bush (*Viburnum alnifolium*) not far away in the same town, both of the last two species characteristic of more northern upland woods.

Harris's list serves very effectively to up-date Robinson's Flora by adding numerous species that were either not present or had not been reported in 1880, and it gives much additional information not included by Robinson. It furnishes extensive coverage for an area that has lacked adequate treatment in a single volume for nearly a century. It also stands as a testimonial to the competence of Stuart Harris as a taxonomist, and the sections contributed by others serve as a fitting memorial to a highly respected botanist whose life was all too short.

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CAREX GEYERI: REVISITED

PAUL E. ROTHROCK

In this journal over 35 years ago, R. T. Clausen and H. A. Wahl (1939) first reported the occurrence of *Carex geyeri* Boott (a typically Rocky Mountain sedge ranging from British Columbia and Alberta to Colorado, Utah, and northern California) in the Eastern United States. This site:

> By limestone outcroppings, in dry deciduous woods on bluffs and slopes on west side of Spring Creek near west boundary of grounds of State Penitentiary, Rock, north of Lemont, Centre Co. [Pennsylvania]

apparently still represents the only known locality for this species east of Colorado.

With the assistance of Dr. Wahl, I was able to relocate *Carex geyeri* in May, 1975. The area has remained undisturbed and, except for sapling growth, mostly unchanged. Clumps of *C. geyeri* were observed in 3 distinct areas along a quarter mile stretch of the bluff and have been seen at various times in similar habitats slightly downstream (Wahl, personal communication). These clumps showed a full range of vigor: fully half were setting fruit, others had aborted fruit (perhaps due to lack of proper pollination?), while several clumps were only persisting vegetatively.

The bicentric distribution of this sedge may have arisen either through introduction by man in recent years or by some more natural means. Hermann (1970) favors the first hypothesis, but Clausen and Wahl made definite note of the natural undisturbed aspect of the habitat. Furthermore, it should be noted that the nearest major travel routes, i.e., railroads, highways, or waterways, are at least several miles away thereby making introduction by man unlikely. Since other East-West disjuncts are known (see

Wood, 1970, for a full discussion) and considering the relatively sizable area these plants cover, the localized, distinctive nature of the habitat, and the period of time over which *C. geyeri* has been known for this site (first discovered in 1932), I believe that the occurrence of this sedge in central Pennsylvania represents a relict disjunct of phytogeographical importance.

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